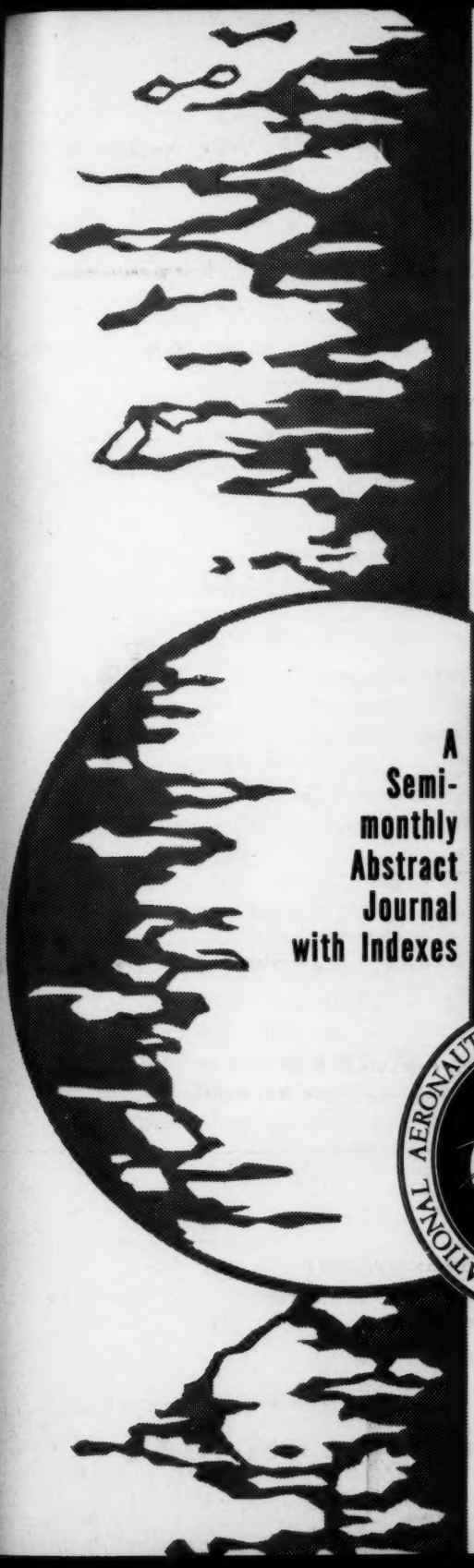

Scientific and Technical Aerospace Reports

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VOLUME 1 NUMBER 7

N63-12842—N63-13325

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, December 20, 1962

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Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 11 Fluid Mechanics.

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES 417

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics

04 AIRCRAFT 420

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

05 ASTRONOMY AND ASTROPHYSICS 422

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06 AUXILIARY SYSTEMS 423

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters.

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For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

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21 METEOROLOGY 462

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For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

22 NAVIGATION AND GUIDANCE 462

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For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.

23 PHYSICS, GENERAL 463

Includes: acoustics; cryogenics; optics; and thermodynamics.

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25 PHYSICS, SOLID-STATE 473

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26 PROPELLANTS AND COMBUSTION 474

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For related information see: 07 Chemistry; and 27 Propulsion.

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Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

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For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

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For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

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VOLUME 1 NUMBER 7

Scientific and Technical Aerospace Reports

A Semimonthly Publication
of the National Aeronautics and Space Administration

April 8, 1963

01 GENERAL

Includes: management; space law and legal matters; symposia or conferences of a broad or a general nature.

N63-12924 Associated Universities, Inc., Upton, N.Y.
BROOKHAVEN NATIONAL LABORATORY ANNUAL REPORT, JULY 1, 1962
[1962] 201 p 955 refs
(Contract AT(30-2)-GEN-16)
(BNL 742(AS-16)) OTS: $3.00

This report covers the following: physics, high-energy accelerators, instrumentation, chemistry, nuclear engineering, applied mathematics, biology, and medical research. J.R.C.

N63-13015 Hanford Atomic Products Operation, Richland, Wash.
RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT Quarterly Progress Report, July, August, September, 1962
M. M. Hendrickson and J. E. Brown, eds. Dec. 1962 143 p 24 refs
(Contract AT(45-1)-1350)
(HW-75914) OTS: $2.50

Studies on the basic properties of plutonium and uranium ceramic materials, plutonium and uranium fuel fabrication methods, physics, chemical processing of reactor fuels and radioactive waste, materials development, irradiation effects on materials, fuel cycle analysis and advanced concepts, instrumentation, and nondestructive testing techniques are reviewed. I.v.L.

N63-13064 Battelle Memorial Inst., Columbus, Ohio
A GUIDE TO THE SCIENTIFIC AND TECHNICAL LITERATURE OF EASTERN EUROPE
Beverly A. Rawles and Inez B. Wheldon, comps. Washington, Natl. Sci. Foundation, Oct. 1962 99 p 440 refs Appendix contains a selected list of scientific and technical periodicals
(NSF-62-49)

The purpose of this publication is to provide a guide to the scientific and technical literature of Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Rumania, and Yugoslavia. It is intended for use by scientists, librarians, and students. It contains information on the announcement, availability, procurement and translation of east european publications in the physical, biological, and certain of the social sciences. Medicine (except experimental medicine) and agriculture are excluded. The appendix contains an annotated list, by subject, of the periodicals of the various east european countries. I.v.L.

N63-13130 Royal Aircraft Establishment, Farnborough (Gt. Brit.)
EXPERIMENTS ON MAN CONSIDERED AS A PROBLEM AFFECTING BOTH MEDICINE AND THE LAW (EXPERIMENTE AM MENSCHEN ALS MEDIZINISCHRECHTLICHES GRENZPROBLEM)
E. Lauppi London, Ministry of Aviation, Nov. 1962 10 p 7 refs Transl. by B. F. Toms from Praxis, 33(1961) p 837-841
(RAE Library Translation-1017)

The legal principles concerning the performance of medical experiments on man are discussed. The principles of Swiss law are considered in the first instance. The ethical aspects of the subject are not considered since they are part and parcel of medical training and need no commentary. Therapeutic trials and experiments on healthy persons are considered. In this field the same legal criteria hold good as for other aspects of medical practice. Author

N63-13139 Research Analysis Corp. Methodological Research Div., Bethesda, Md.
MODES OF INQUIRY AND RESEARCH TASKS FOR GENERAL SYSTEMS ANALYSIS
Nicholas M. Smith and Milton C. Marney Dec. 1962 22 p 5 refs Presented as Paper P-4 at 22d Nat. Meeting of the Operations Research Soc. of America, Philadelphia, 7-9 Nov. 1962
(Contract DA-44-188-ARO-1)
(RAC-TP-72)

Any attempt to establish a general perspective for the special disciplines associated with general systems analysis must encompass the orientation of modes of inquiry and research tasks that couple functionally with a correspondent structuring of the field of phenomena. Such a project is attempted in this study under our conception that the range of general systems analysis is the domain of adaptive systems. Certain metascientific considerations indicate that an adequate treatment of this domain, particularly with respect to complex organizations, will require the exploitation of a potential innovation emerging from the current prototype of rational inquiry, i.e., the presently accepted model of scientific thought. Examination of successive historic modifications of scientific method reveals that the "conceptual" mode of inquiry most recently developed in physical science presents the possibility of reinterpretation as a formal dual. That is, an "introspective" as well as an "extrospective" format ensues formally from the rational foundations of the conceptual mode of inquiry, and these dual perspectives of inquiry are shown to be complementary. This version of complementary leads immediately to (1) a resolution of philosophical disputes that have heretofore blocked the development of a significant theory of value, and hence a general theory of decision; (2) an extension of the range of research generally conceived for operations research; and (3) a new structuring of research tasks under both formal and empirical divisions. Author

N63-13146 Matrix Corp., Arlington, Va.
DEVELOPMENT OF QUALITATIVE AND QUANTITATIVE PERSONNEL REQUIREMENTS INFORMATION [Final Report]

Walter L. Smith, Melvin T. Snyder (Behavioral Sciences Lab.) Robert G. Demaree, and Melvin R. Marks Wright-Patterson AFB, Ohio, Aerospace Med. Res. Labs. (6570th), Dec. 1962 88 p 211 refs
(Contract AF 33(616)-7464)
(MRL-TDR-62-4) OTS: $2.25

This report describes the nature of, purpose, and method for developing Qualitative and Quantitative Personnel Requirements Information (QQPRI). The nature and scope of QQPRI and the relationship of QQPRI to system development are covered. The general constraints within which QQPRI is developed are described. Such constraints include technical weapon system constraints, as well as policies on Air Force Personnel, Training, and Manning. Emphasis is placed on QQPRI development techniques such as task analyses, estimation of performance time, establishing Air Force positions, and determining the relation of these to existing Air Force specialities. Author

N63-13184 National Aeronautics and Space Administration, Washington, D.C.
RESEARCH PROBLEMS PERTAINING TO AIRCRAFT OPERATIONS
William A. Mc Gowan and William S. Aiken, Jr., eds. March 1963 32 p
(NASA TN D-1596) OTS: $1.00

Research problems are presented under the following 12 categories: (1) vehicle performance, (2) vehicle structures, (3) vehicle powerplants, (4) fire hazards, (5) environment, (6) stability and control, (7) air traffic control and communication, (8) collision avoidance, (9) instrumentation, (10) medical and human factors, (11) crashworthiness, and (12) community relations. Specific recommendations of research studies needed in each of the categories are given and discussed. Author

N63-13191 Frankford Arsenal, Philadelphia, Pa.
BASIC RESEARCH IN PHYSICAL SCIENCES Second Quarter Progress Report for FY 63
George C. White, Jr., et al Dec. 1962 53 p refs

Basic research in the physical sciences covers the following: effect of radiation on chemical reactions; urea inclusion compounds; structure of radioactive atoms; defect migration in metals; tetrazole chemistry; stresses in dynamic photoelasticity; optical studies of alloys; solid-state optical pumping; kinetics of binary alloys; compressible fluid flow about axially symmetric bodies; order-disorder transformations in alloys; phase changes in Cu-Ni and Cu-Zn by nuclear radiation; high purity single crystals; additive coloration in alkali halides; electronic properties of solid solutions; diffusion of ions in solution through isolated zirconium-oxide films; fracture of metals; strong interaction optic waves in solids; band structure of beta-brass type alloys; friction and wear; Debye temperatures; nitro-organics exposed to radiation; radiolysis and photolysis of propargyl bromide; synthesis of stable fluids; and intermolecular vibrations in molecular crystals. J.R.C.

N63-13213 Library of Congress. Science and Technology Div., Washington, D.C.
MATERIALS RESEARCH ABSTRACTS. A REVIEW OF THE AIR FORCE MATERIALS RESEARCH AND DEVELOPMENT
Charles D. Thibault, ed. 1962 536 p 2349 refs
(Supported by Directorate of Materials and Processes, Wright-Patterson AFB, Ohio)

A review of the Air Force materials research and development is presented in the form of an annotated bibliography. It includes the following fields: chemistry and biochemistry, materials, physical metallurgy and solid state physics, and problems in materials testing and application. I.v.L.

N63-13233 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho
MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES Quarterly Report, July 1-September 30, 1962
J. R. Huffman et al AEC Nat. Reactor Testing Station, Jan. 15, 1963 61 p 54 refs
(Contract AT(10-1)-205)
(IDO-16827)

Fields of investigation at Materials Testing Reactor-Engineering Test Reactor Technical Branches included: (1) reactor physics and engineering, encompassing reactor experiments and reactor fuels and materials development; (2) nuclear physics, encompassing cross sections program; nuclear chemistry; inelastic scattering of slow neutrons; theoretical physics; and low-energy nuclear physics decay scheme studies; (3) instrument development, encompassing digital systems instrumentation; special electronic instrumentation; and detector development; (4) applied mathematics, resulting in establishment of a library of nuclear codes for the IBM 7090 Fortran monitor system and nonlibrary codes ready for use at Bartlesville; detector response curve generation for gamma spectrometry; linear least squares program for the analysis of gamma spectra; and IREKIN, a 7090 program for reactor kinetics. I.v.L

N63-13234 Library of Congress. Science and Technology Div., Washington, D.C.
CHARLES J. CLEARY AWARDS FOR PAPERS ON MATERIAL SCIENCES
Lynn E. Catoe, ed. 1962 216 p 359 refs
(Supported by Wright-Patterson AFB, Ohio)

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3. ELEVATED-TEMPERATURE TESTING PROCEDURES. CONTINUOUS RECORDING OF TIME-DEFORMATION READINGS DURING CREEP-RUPTURE TESTING AT TEMPERATURES UP TO 1200° F W. H. Rector (Arcweld Mfg. Co.) p 39-48 (See N63-13237 07-33)
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9. DERIVATIVES OF FERROCENE. PART III. THE PREPARATION OF SOME ACYLFERROCENES AND ALKYLFERROCENES M. D. Rausch (Monsanto Chemical Co.), M. Vogel (Rutgers U.), and H. Rosenberg (Aeron. Systems Div.) p 121-124 13 refs (See N63-13243 07-07)
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13. INITIAL YIELDING AND FRACTURE IN NOTCHED SHEET MOLYBDENUM R. T. Ault (Aeron. Systems Div.) p 189-219 49 refs (See N63-13247 07-18)

N63-13260 Tokyo U. Inst. of Industrial Science (Japan)
SOUNDING ROCKET MANAGEMENT AND ADMINSTRATION
Junjiro Shimomura *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 149-156 (See N63-13251 07-04) OTS: $3.00

The growth of Japan's sounding-rocket program is reviewed, and the present organization is described. The National Budget for the program has increased from ¥57,425,000 in 1955, with the decision to join IGY, to ¥167,531,000 in 1960. The program is managed by the Rocket Sounding Council (ROKK) which was established by the Japan Science Council. R.C.M.

N63-13266 European Atomic Energy Community, Brussels (Belgium)
EURATOM'S RESEARCH ACTIVITIES—AN ILLUSTRATION: THE ORGEL PROGRAM
J. Guéron and J. C. Leny Nov. 1962 33 p Presented at the Nuclear Congress, New York, June 4-7, 1962
(EUR-110.e) Available from Belgian American Bank and Trust Co., N.Y., account No. 121.86: 30 Belg. Fr.

According to the provisions of the Euratom Treaty, EURATOM aims at helping national programs and at carrying out independent actions which are not included in the national plans. These actions are carried out in three Common Research Centers—at Ispra (Italy), Petten (The Netherlands), and Geel (Belgium). Some of these actions are managed from Brussels, which is the case for the ORGEL Program. The objectives of this Program are outlined. Author

N63-13276 Union Carbide Nuclear Co., Oak Ridge, Tenn.
GRAPHICAL CPM
J. T. Huffstetler Feb. 25, 1963 47 p 6 refs
(Contract W-7405-eng-26)
(K-1534)

Modification of the Critical-Path Method has been made to eliminate the requirement for a high-speed electronic digital computer and make the method more useful to the operating foreman. Basic arrow diagraming is presented in a simplified form, and a block-level chart is explained for scheduling projects within the limits of available manpower and equipment. This modification of the Critical-Path Method gives the foreman a graphical chart for planning, status reporting, on-the-job rescheduling; requires very little experience; eliminates the need for a computer or the mathematics usually associated with CPM; provides a good basis for accurate estimating; can be used on large projects as well as the small ones for which it was designed. Author

N63-13309 Battelle Memorial Inst., Columbus, Ohio
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING NOVEMBER, 1962
Russell W. Dayton and Ronald F. Dickerson Dec. 1, 1962 79 p 2 refs
(Contract W-7405-eng-92)
(BMI-1603(Del.)) OTS: $2.00

Potential civilian applications for some reactor materials, components, and fuels are discussed. B.J.C.

N63-13314 Advisory Group for Aeronautical Research and Development, Paris (France)
AGARD GENERAL INFORMATION 1962
Theodore von Kármán 1962 51 p

The organization of the Advisory Group for Aeronautical Research and Development (AGARD) of the North Atlantic Treaty Organization (NATO) is given along with an outline of the activities of the AGARD panels and committees. R.C.M.

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors and Control Surfaces; and 11 Fluid Mechanics.

N63-12912 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC PERFORMANCE AND STATIC STABILITY AT MACH NUMBERS UP TO 5 OF TWO AIRPLANE CONFIGURATIONS WITH FAVORABLE LIFT INTERFERENCE
David H. Dennis and Richard H. Petersen Washington, NASA, Jan. 5, 1962 47 p 16 refs
(NASA MEMO 1-8-59A) OTS: $1.25 (Declassified)

Six-component force tests were conducted through a range of Mach numbers from 0.6 to 5.0 on wing-body configurations with and without vertical fins. The test models were designed for efficient flight at a Mach number of 3.0. Fins and wing dihedral were employed to provide adequate directional and lateral stability at Mach number 3. The wings had modified triangular planforms with 70° leading-edge sweep and 2.5-percent-thick sections. Methods based on linear theory were employed to estimate the performance characteristics of the models and their stability characteristics at zero angle of attack at Mach numbers from 3.0 to 5.0. Measured maximum lift-drag ratios at Mach number 3.0 were from 6 to 7 (excluding body base drag), the latter value being for the most efficient configuration without a vertical fin. The addition to this configuration of a vertical fin sufficient to provide adequate directional stability resulted in a reduction of maximum lift-drag ratio to 6½. This model, with moment reference center at 28 percent of the mean aerodynamic chord, was found to be statically stable throughout the test Mach number range near the angles of attack required for maximum lift-drag ratio. Estimated values of performance and longitudinal static margin, and vertical fin effectiveness at zero angle of attack were found to be in relatively good agreement with measured values. Author

N63-12913 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

AERODYNAMIC CHARACTERISTICS OF SEVERAL FLAT-BOTTOM CONFIGURATIONS AT MACH 3.0 AND 3.5

Murray Dryer and Roger W. Luidens Washington, NASA, Jan. 1959 42 p 14 refs
(NASA MEMO 1-2-59E) OTS: $1.25 (Declassified)

Several unconventional aerodynamic configurations were experimentally investigated in the Lewis 1- by 1-foot tunnel at Mach 3.0 and in the 10- by 10-foot tunnel at Mach 3.0 and 3.5. Briefly examined were the following design variables: forebody shape, forebody cant, afterbody taper, wing shape, and engine installation. Results in terms of maximum lift-drag ratio $(L/D)_{max}$ as well as the effect of engine installation on directional stability and local inlet Mach numbers are discussed. Also included is the effect of Reynolds number variation on $(L/D)_{max}$; for example, $(L/D)_{max}$ increased from 7.1 to 8.3 as the Reynolds number was increased from 6.6×10^6 to 20×10^6 at Mach 3.0 for one of the configurations. Author

N63-12916 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS AT A MACH NUMBER OF 3.11 OF SQUARE AND CIRCULAR PLAN-FORM REENTRY VEHICLES, WITH SOME EFFECTS OF CONTROLS AND LEADING-EDGE EXTENSIONS

Byron M. Jaquet Washington, NASA, May 1960 23 p 4 refs
(NASA TM X-272) OTS: $2.60 ph, $0.89 mf (Declassified)

Results are presented of an investigation to determine the static longitudinal and lateral stability and some control characteristics of a square planform reentry vehicle with leading-edge extensions and a circular planform reentry vehicle with pyramidal controls. Tests were made at Reynolds numbers per foot of 12.050×10^6 to 13.060×10^6 and at angles of attack from approximately -5° to 13° at two sideslip angles, 0° and 6°. Author

N63-12918 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVESTIGATION AT SUBSONIC SPEEDS OF AERODYNAMIC CHARACTERISTICS AT ANGLES OF ATTACK FROM -4° TO 100° OF A DELTA-WING REENTRY CONFIGURATION HAVING FOLDING WINGTIP PANELS

Bernard Spencer, Jr. Washington, NASA, May 1960 29 p 9 refs
(NASA TM X-288) OTS: $0.75 (Declassified)

The configuration is of the type used in a high angle-of-attack (near 90°) reentry to minimize aerodynamic heating. By unfolding the wing-tip panels into the airstream, a moderate angle-of-attack glide is used for a controlled landing. The basic configuration tested utilized a 73° sweptback delta wing and 47.24° sweptback wing-tip panels whose area was 25 percent of the total wing area. The effects of varying the planform and size of the wing-tip panels were studied as well as the effects of unfolding the wing-tip panels in a high angle-of-attack attitude. Tests were made at Mach number of 0.40, 0.60, and 0.80 over an angle-of-attack range from approximately -4° to 100°. Author

N63-12950 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS OVER THE FORWARD PORTION OF THE PROJECT FIRE SPACE-VEHICLE CONFIGURATION AT MACH NUMBERS FROM 0.25 TO 0.60

William P. Henderson Washington, NASA, Feb. 1963 28 p
(NASA TN D-1612) OTS: $0.75

An investigation was made in the Langley 7- by 10-foot transonic tunnel to determine the pressure distributions over a 0.0628-scale model of the forward portion of the Project Fire space-vehicle configuration. Tests were made at Mach numbers of 0.248, 0.395, and 0.585. Data are presented for the model at angles of attack ranging from -8° to 8° and at roll angles of 0°, 15°, 30°, 50°, and 90°. Author

N63-12975 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS OF A 0.0667-SCALE MODEL OF THE NORTH AMERICAN X-15 RESEARCH AIRPLANE AT TRANSONIC SPEEDS

Robert S. Osborne Washington, NASA, Sept. 1959 109 p 3 refs
(NASA TM X-24) OTS: $2.50 (Declassified)

In order to determine its aerodynamic characteristics at transonic speeds, a 0.0667-scale force model of configuration 1 of the North American X-15 research airplane has been tested in the Langley 8-foot transonic pressure tunnel at Mach numbers from 0.60 to 1.43, angles of attack up to 20°, and angles of sideslip from 0° to 5.1°. The drag of the configuration was relatively high; the maximum lift-drag ratios decreased from 6.7 to approximately 4.5 with increases in Mach number from 0.60 to 1.43. Positive longitudinal stability was indicated for the model except at Mach numbers near 0.95 where neutral stability occurred at approximately zero lift. The configuration was stable directionally and had positive effective dihedral for the ranges investigated. The horizontal tail provided satisfactory longitudinal and lateral control power. Differentially deflecting the horizontal tail for lateral control produced large favorable yawing moments at low angles of attack but had little effect on longitudinal stability and control. Opening the speed brakes 45° at a Mach number of 1.43 increased zero-lift drag by a factor of 5, produced large longitudinal trim changes, increased directional stability by 30 percent, and doubled effective dihedral at the lower angles of attack. Author

N63-12976 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN GUIDE FOR PITCH-UP EVALUATION AND INVESTIGATION AT HIGH SUBSONIC SPEEDS OF POSSIBLE LIMITATIONS DUE TO WING-ASPECT-RATIO VARIATIONS

Kenneth P. Spreemann Washington, NASA, Aug. 1959 38 p 23 refs
(NASA TM X-26) OTS: $1.00 (Declassified)

A design guide is suggested as a basis for indicating combinations of airplane design variables for which the possibilities of pitch-up are minimized for tail-behind-wing and tailless airplane configurations. An investigation of one possible limitation of the guide with respect to the effects of wing-aspect-ratio variations on the contribution to stability of a high tail indicated that the design guide may not be applicable below an aspect ratio of about 2.0. Author

N63-12980 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECTS OF WING-CRANK, LEADING-EDGE CHORD EXTENSIONS AND HORIZONTAL-TAIL HEIGHT ON THE LONGITUDINAL STABILITY OF SWEPT-WING MODELS AT MACH NUMBERS FROM 0.6 TO 1.4

Roy M. Wakefield Washington, NASA, Oct. 1959 117 p 11 refs
(NASA TM X-92) OTS: $9.60 ph, $3.71 mf (Declassified)

A wind-tunnel investigation from 0.6 to 1.4 Mach number has been made to determine the effects of wing modifications and horizontal-tail height on the longitudinal stability of models with low aspect ratio, 53.1° sweptback wings. Wing planform modifications evaluated were wing crank, leading-edge chord extension, and reduction of wing leading-edge sweepback. Pitching-moment characteristics of models without a horizontal tail, and with a horizontal tail above the wing chord plane, were improved by the wing modifications. Author

N63-12981 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS AT MACH NUMBER 2.01 OF AN AIRPLANE CONFIGURATION HAVING A CAMBERED AND TWISTED ARROW WING DESIGNED FOR A MACH NUMBER OF 3.0

Odell A. Morris and A. Warner Robins Washington, NASA, Sept. 1959 34 p 3 refs
(NASA TM X-115) OTS: $1.00 (Declassified)

An investigation has been conducted to determine the aerodynamic characteristics in pitch at Mach number 2.01 of an airplane configuration having an arrow wing with 75° of leading-edge sweep and with camber and twist to produce an optimum load distribution at a lift coefficient of 0.1 and a Mach number of 3.0. NACA RM L58E21 reports the results of previous tests of the same airplane configuration at Mach numbers of 2.36 and 2.87. The aspect ratio for the configuration is 1.79, and wing-thickness ratios normal to the leading edges vary from 8 to 14 percent. Tests of the complete configuration and of various combinations of components were made with the original wing apex and the modified wing apex. Additional tests were made to determine the effects of wing fences and wing-body-juncture fairings on the upper-surface flow. Reynolds number for all tests, based on the mean geometric chord, was 5.8×10^6. Transition was fixed near the leading edges of all components. The maximum lift-drag ratio of 7.0 for the complete configuration at Mach number 2.01 showed little or no increase over that previously measured at Mach number 2.36. Luminescent-oil-flow studies showed that despite the lower initial component of velocity normal to the leading edges at Mach number 2.01, the flow separated in the same manner as it had at Mach numbers of 2.36 and 2.87. The use of fences and large wing-body-juncture fairings increased the lift-drag ratio by about 0.3. The lift-drag ratio was essentially unaffected by the appreciable modification of the wing apex. Author

N63-12983 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL AT HIGH SUBSONIC SPEED OF THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A WINGED REENTRY VEHICLE HAVING A LARGE NEGATIVELY DEFLECTED FLAP-TYPE CONTROL SURFACE

Paul G. Fournier Washington, NASA, Dec. 1959 21 p 10 refs
(NASA TM X-179) (Declassified)

Results were obtained through an angle-of-attack range from -2° to 90° on a vehicle having flap-type control surfaces which could be deflected from 0° to -105°. The Mach number range was from 0.60 to 0.90 with corresponding Reynolds numbers of 2.76×10^6 to 4.03×10^6 based on the basic-wing mean aerodynamic chord. Author

N63-12984 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF THE LOW SUBSONIC FLIGHT CHARACTERISTICS OF A MODEL OF A FLAT-TOP HYPERSONIC-BOOST GLIDE CONFIGURATION HAVING AN ARROWHEAD WING

Peter C. Boisseau Washington, NASA, Dec. 1959 22 p 6 refs
(NASA TM X-193) (Declassified)

An investigation of the low-speed stability and control characteristics of a model of a flat-top hypersonic-boost glide configuration having a 77.4° sweep of the leading edge has been made in the Langley full-scale tunnel. The model was flown over an angle-of-attack range from about 10° to 35°. Static force tests were made in the Langley free-flight tunnel. Author

N63-13002 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.

HEAT TRANSFER IN SHOCK WAVE-TURBULENT BOUNDARY LAYER INTERACTION REGIONS

S. Sayano Nov. 19, 1962 65 p 15 refs
(SM-42567)

An experimental investigation was conducted to obtain heat transfer and pressure distributions in the interaction region of an oblique shock wave impinging on a turbulent boundary layer. Four Mach numbers ranging from 2.4 to 5, shock wave deflection angles of 8°, 15°, and 26°, and boundary layers generated (1) by a flat plate and (2) by a cone-cylinder body were covered in the experiments. Steady-state temperatures and pressures along a cooled instrumented plate were recorded. Heat-transfer distributions were obtained from these steady-state temperatures. The interaction between an oblique shock wave and a boundary layer produces an increase in the static pressure which in turn increases the local heat-transfer coefficient. Comparisons of peak heat transfer and pressure rises in the region of interaction with the calculations based on a simple inviscid flow model are presented and discussed herein. Empirical correlations are made between the peak heat-transfer-coefficient ratio and incident shock strength as well as between the peak pressure ratio and incident shock strength. These correlations show that the peak values for the cylinder case are lower than the corresponding flat plate values. The empirical equation, which states that the peak heat-transfer-coefficient ratio is proportional to the 0.8 power of peak pressure ratio, fits well with the experimental data for both flat plate and cylinder cases in turbulent flow. Author

N63-13003 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.

A CRITICAL STUDY OF THE DIRECT BLUNT BODY INTEGRAL METHOD

W. A. Anderson and J. Xerikos Dec. 28, 1962 89 p 17 refs
(SM-42603)

A representative formulation of the one-strip blunt-body integral method is treated in sufficient detail to delineate the numerical difficulties involved in its mechanization as well as to identify limitations in its application. While the integration of the governing system of equations for general body shapes comprises a two-point boundary-value problem, the particular case of a flat-faced cylinder is shown to reduce to a procedure involving a single integration. An investigation is made of the extent to which conservation laws are satisfied throughout the shock-layer region. Significant deviations are found to exist depending upon the method used for computing the distribution of flow properties across the shock layer. A procedure has been chosen which ensures compatible tangential and normal flow property gradients at the shock and body while significantly reducing mass and momentum defects in most instances. Computed flow field data are presented for spheres and flat-faced cylinders. Author

N63-13004 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.

PRESSURE DISTRIBUTION ON A WEDGE ACCELERATED IMPULSIVELY AT A SUPERSONIC MACH NUMBER

A. I. Ormsbee Dec. 28, 1962 21 p 5 refs
(SM-42649)

The nonsteady flow equations associated with an impulsively accelerated supersonic wedge were transformed into a time-independent system. This system was then linearized with respect to the velocity change. It was shown that for certain regions of the flow field a velocity potential could be defined, and a formal series solution for the potential in these regions was found. It was also shown that the pressure perturbation satisfies Laplace's equation, in a suitably transformed space, for both rotational and irrotational regions. Finally, for the special case of a small wedge angle, the coefficients in the velocity potential series expansion were determined, and a closed-form expression for the pressure field was obtained. Author

N63-13060 United Aircraft Corp. Research Labs., East Hartford, Conn.

FLUID AMPLIFICATION Interim Report No. 6 on Aerodynamic Studies of Pure-Pneumatic Systems

Robert E. Olson Oct. 12, 1962 132 p 10 refs
(Contract DA-49-186-ORD-912)
(A-1771-16)

Theoretical and experimental investigations were conducted to provide information regarding the aerodynamic characteristics of two-dimensional compressible jets. The investigations included studies of both free jets and attached jets (i.e., jets, initially unattached, which subsequently attach on one side to a boundary wall). The theoretical studies provided analytical models for both classes of jets, a procedure for predicting the velocity profile development for free jets, and a procedure for predicting the reattachment location and mean pressure in the separation bubble between the nozzle exit and the reattachment point for the attached jets. The experimental studies were conducted in wind-tunnel facilities at the UAC Research Laboratories for initial jet Mach numbers in the range from 0.66 to 2.0. Measurements were made of flow profiles at various stations downstream of the nozzle exit for both classes of jets. For the attached jets, additional measurements were made of wall static-pressure distributions and the pressure recovery and weight-flow characteristics of diffusion systems attached to the bounding wall downstream of the reattachment point. Good correlation between theory and experiment was found for the free jets using constant-exchange coefficient mixing-theory with Prandtl's concept for the turbulent-exchange coefficient and a Gaussian velocity distribution in the mixing zone. For the attached jets it was found that the analytical procedure, which assumed the jet characteristics upstream of reattachment were similar to the free jets, could be employed for predicting the location of the reattachment point. Tests with a diffuser installed downstream of the reattachment point showed that the diffuser pressure recoveries for the case of no spillage flow could be predicted using average flow properties obtained from measured profiles in the jet without the diffuser installed. Author

N63-13105 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CALCULATIONS OF COMPRESSIBLE AVERAGE TURBULENT SKIN FRICTION

Mitchel H. Bertram Washington, NASA, 1962 34 p 23 refs
(NASA TR R-123) GPO: $0.40

Calculations have been carried out for a perfect-gas flow to show the effect of a wide range of parameters on the average skin friction on a flat plate in turbulent flow by the reference-temperature method (however, to some extent laminar flow was also treated). Some of the variables were Mach number, Reynolds number, and wall and free-stream temperature level for ratios of specific heats of 7/5 and 5/3. The effect of the blunt leading edge was calculated by assuming that the turbulent boundary layer is growing in the reexpanded flow behind a normal shock at various free-stream Mach numbers. Analogous to angle of attack, the pressure level on the plate was varied over a wide range to show the effect on skin friction for the plate with sharp and blunt leading edges. Relations which allow the results to be applied to cones and wings of tapered planform were shown. Author

N63-13106 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A PRELIMINARY THEORETICAL STUDY OF THE EXPANSION TUBE, A NEW DEVICE FOR PRODUCING HIGH-ENTHALPY SHORT-DURATION HYPERSONIC GAS FLOWS

Robert L. Trimpi Washington, NASA, 1962 31 p 12 refs
(NASA TR R-133) GPO: $0.40

A preliminary theoretical study was conducted of a new technique for producing high-enthalpy gas flows. The device considered utilizes an unsteady expansion process for the purpose of total-enthalpy multiplication. Analyses were conducted for both perfect and real air in equilibrium, assuming idealized diaphragm bursts, centered expansion waves, and continuum flow. Results of the study showed the expansion tube capable of outperforming the conventional shock tunnel by a factor of approximately 2 in velocity for the same test-section ambient density and pressure. The degree of dissociation is low at all phases of the thermodynamic cycle in the expansion tube; thus the test-section air has a good possibility of being in equilibrium. Maximum pressures involved in the cycle for duplicating a typical reentry from a lunar mission are low enough for existing pressure-vessel techniques. Both the known and anticipated advantages and disadvantages of this new concept are also discussed. Author

N63-13108 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE EFFECT OF CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A BODY AT A MACH NUMBER OF 2.01

John P. Gapcynski Washington, NASA, Sept. 1959 19 p 4 refs
(NASA TM X-56) OTS: $0.50 (Declassified)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the effect of camber on the aerodynamic characteristics of an ogive-circular-cylinder type of body with a fineness ratio of 10. Three types of camber were considered: the first being a simple body nose droop of 4°, and the second and third being distortions such that the body center lines had, respectively, circular-arc and reflexed circular-arc shapes. Both force and pressure measurements were obtained on the models at a Mach number of 2.01, a Reynolds number per foot of 3.46×10^6, and for an angle-of-attack range of $\pm 10°$. The use of camber resulted in pronounced changes in the body pitch characteristics. Drooping or lowering the nose of the body introduced a negative increment in the pitching-moment variation (pitch center at body midpoint) with little change in the normal-force values. Drooping the rear portion of the body as well as the nose resulted in still more negative pitching-moment increments but positive normal-force increments. The use of nose droop with a raised afterbody resulted in positive pitching-moment increments and negative normal-force increments. Fairly good predictions of the trend and order of magnitude of these pitch characteristics were possible with the application of slender-body theory. Minimum drag values for the bodies with the drooped nose and circular-arc center line were higher than that of the uncambered body. Little or no increase was noted for the body with the reflexed circular-arc center line. Author

N63-13186 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPLORATORY INVESTIGATION OF THE EFFECT OF A FORWARD-FACING JET ON THE BOW SHOCK OF A BLUNT BODY IN A MACH NUMBER 6 FREE STREAM

David J. Romeo and James R. Sterrett Washington, NASA, Feb. 1963 46 p 12 refs
(NASA TN D-1605) OTS: $1.25

The effect of a forward-facing jet on the bow shock of a blunt body in a Mach 6 free stream was investigated experimentally. The models tested had forward-facing jets using air and helium exhausting at Mach numbers from 1 to 10.3 and were run through a range of the ratio of jet total pressure to free-stream total pressure of 0.03 (jet off) to 2.5. The ratio of body diameter to jet-exit diameter varied from 1.12 to 55.6 and the angle of attack was varied from 0° to 35°. The experimental results show that the main-stream shock can be affected by the jet in two significantly different ways. One way is simply to move the strong shock away from the body without altering its shape. The second and perhaps more interesting case occurs when the jet causes a large displacement of the main shock and considerably changes its shape. It was found that the ratio of jet total pressure to free-stream total pressure necessary to obtain the large displacements of the main-stream shock depended on the ratio of body diameter to jet-exit diameter and also on the jet-exit Mach number. The maximum amount the shock could be displaced in percent of body diameter was seen to increase with increasing jet-exit Mach number and also with decreasing ratio of body diameter to jet-exit diameter. For the models that were investigated through an angle-of-attack range, the displacement became very unsteady and fell

off sharply as the angle of attack was increased. Simplified theoretical considerations applied to the shock-displacement phenomena provide a possible explanation for the two different types of mainstream shock displacement. Theoretical curves show the regions where these types of displacement would occur for different exit Mach numbers and pressure ratios for a forward-facing jet in a Mach 6 stream. Author

N63-13203 Aberdeen Proving Ground. Ballistic Research Labs., Md.

DESIGN OF AIRCRAFT REVETMENTS

George A. Coulter and Robert L. Peterson Oct. 1962 84 p 10 refs (Partially supported by DASA)
(BRL-MEMO-1440)

Airflow over two-dimensional model revetments, mounted in the 4 × 15-in. shock tube, was traced by means of cigarette-smoke grids photographed by a high-speed framing-camera. Tables of densities, flow speeds, and directions of flow, computed from the photographs, are given for an input shock wave of 8.3 psi average overpressure. Flow vectors are shown to illustrate the differences in the flow patterns for the different revetments tested. Author

N63-13257 Tokyo U. Inst. of Industrial Science (Japan)

AERODYNAMICS OF THE KAPPA ROCKET

Akio Tamaki *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 122-132 17 refs (See N63-13251 07-04) OTS: $3.00

The aerodynamic characteristics of the Kappa sounding rockets were studied by wind-tunnel and flight tests. The wind-tunnel tests were carried out in the 2-meter subsonic tunnel, in the 15-cm X 15-cm supersonic tunnel, and in the 5-cm low density wind tunnel. Flight stability tests were performed with rockets having different C.G.'s to determine the best stabilizing point. The drag coefficient was found to be 0.58 for the booster section of the Kappa-8 rocket. R.C.M.

N63-13302 Bombrini Parodi-Delfino S. p. A. Centro di Calcolo Electtronico, Rome (Italy)

EVALUATION OF THE AEROTHERMODYNAMIC FIELD PRODUCED BY A PSEUDO-SPHERIC BODY OF MERCURY TYPE AT M = 22.6 FLYING IN AIR IN THERMODYNAMIC EQUILIBRIUM

Dante Cunsolo and Silvio Angelucci [1962] 43 p 21 refs

The differential equations valid after the shock are first given in curvilinear coordinates; the chosen unknowns are the two velocity components and the entropy and enthalpy. A function of entropy and enthalpy is then determined, by means of which all the thermodynamic variables of the fluid are "coherently" approximated. Later on, the density and all the other kinematic and thermodynamic variables are calculated immediately after the shock, taking the angle σ as a parameter. The shape of the body is now taken into account, and a convenient shape of the shock wave is given. The differential equations are then integrated with a step-by-step procedure, until the stagnation entropy is reached on the body. Finally the pressure and the temperature on the body are given. A sonic-to-stagnation pressure of 0.580 is the result, instead of 0.523 for a perfect gas. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N63-12895 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RESULTS OF WIND-TUNNEL MEASUREMENTS ON A HELICOPTER ROTOR OPERATING AT EXTREME THRUST COEFFICIENTS AND HIGH-TIP-SPEED RATIOS

G. E. Sweet and J. L. Jenkins, Jr. N.Y., Inst. of the Aerospace Sciences, [1963] 12 p 7 refs Presented at the IAS 31st Annual Meeting, New York, Jan. 21-23, 1963
(IAS Paper-63-73) IAS: $0.50 members, $1.00 nonmembers

Wind-tunnel measurements on a helicopter rotor operating at extreme thrust coefficients (C_T = 0.0035; C_T = 0.0070) and high tip-speed ratios (0.25 to 0.55) were conducted. These measurements were conducted to determine the effect of stall on rotor lift, power, and rotor static stability, and the effect of both stall and tip-speed ratio on blade-flapping motions. Tests were run at a constant rotor tip speed of 215 feet per second which corresponds to a tip Reynolds number of approximately 1.6 million. Rotor forces, torque, and blade flapping and feathering motions were recorded for rotor attitudes of -9.5°, 0.5°, and 10.5°. Results indicated that: (1) The rotor lift was not affected by stall. (2) Rotor profile power increased significantly for conditions that were theoretically unstalled. (3) The nonuniformity of rotor-induced velocity can have a significant effect on blade-section angles of attack for rotor attitudes where the forward-velocity component of inflow is small. (4) The longitudinal rotor flapping did not exhibit any divergent trends when stall was encountered. (5) Stall caused the rotor to exhibit stabilizing trends with changes in angle of attack. I.v.L.

N63-12910 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

PRESSURE DISTRIBUTIONS AND AERODYNAMIC CHARACTERISTICS OF SEVERAL SPOILER-TYPE CONTROLS ON A TRAPEZOIDAL WING AT MACH NUMBERS OF 1.61 AND 2.01

Douglas R. Lord and K. R. Czarnecki Washington, NACA, July 26, 1956 170 p 12 refs
(NACA RM L56E22) OTS: $3.00 (Declassified)

An experimental investigation was made at Mach numbers of 1.61 and 2.01 for a Reynolds number of 3.6 × 10^6, with boundary-layer transition fixed near the wing leading edge, to examine the characteristics of nine spoilers on a trapezoidal wing having the leading edge swept back 23°, an aspect ratio of 3.1, and a taper ratio of 0.4. Pressure-distribution measurements, at angles of attack from -15° to 15°, indicated that the incremental pressure distributions due to the spoiler were in good agreement with previous flat-plate results, within certain limitations. A method for estimating the change in pressure distribution with angle of attack is presented. The spanwise loadings and the integrated lift, bending-moment, and pitching-moment coefficients produced by the various configurations are also presented. Author

N63-12911 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

A WIND-TUNNEL INVESTIGATION OF THE WING LOADS DUE TO DEFLECTED INBOARD AILERONS ON A 45° SWEPT-BACK WING AT TRANSONIC SPEEDS

Atwood R. Heath, Jr. and Ann W. Igoe Washington, NACA, July 21, 1958 102 p 11 refs
(NACA RM L58E12) OTS: $9.10 ph, $3.26 mf (Declassified)

The model consisted of a body and a wing with an aspect ratio of 3, a taper ratio of 0.2, and NACA 65A004 airfoil sections. The flap-type ailerons had chords equal to 30 percent of the local wing chords and had spans that extended outboard from the 18.5-percent semispan station for 39.5 percent of the wing semispan. Pressure measurements were obtained at six spanwise stations for model angles of attack from 0° to about 21° in the Mach number range from 0.80 to 1.03 at Reynolds numbers of 6.4 × 10^6 to 7.7 × 10^6. Presented along with the wing loads are comparisons with calculated loads and some effects of carryover loads. The investigation was made in the Langley 16-foot transonic tunnel. Author

N63-12914 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SOME EFFECTS OF VARIATIONS IN DENSITY AND AERODYNAMIC PARAMETERS ON THE CALCULATED FLUTTER CHARACTERISTICS OF FINITE-SPAN SWEPT AND UNSWEPT WINGS AT SUBSONIC AND SUPERSONIC SPEEDS

E. Carson Yates, Jr. Washington, NASA, Jan. 1960 131 p 17 refs
(NASA TM X-182) OTS: $2.75 (Declassified)

Subsonic and supersonic flutter calculations have been made by the method of NACA Research Memorandum L57L10 for 12 swept and unswept wings in order to evaluate the effects on calculated flutter characteristics of variations in aerodynamic parameters and flow density. Results are compared with experimental data. With linearized-theory aerodynamic parameters used as the basis, the variations of aerodynamic parameters consisted of systematic constant-percent-chord changes in the magnitude (but not in the distribution) of section lift-curve slope. Author

N63-12915 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE AERODYNAMIC CHARACTERISTICS OF A BODY IN THE FLOW FIELD NEAR THE TIP OF A CIRCULAR-ARC WING OF RECTANGULAR PLAN FORM AT A MACH NUMBER OF 2.01

John P. Gapcynski Washington, NASA, Jan. 1960 40 p 2 refs
(NASA TM X-211) OTS: $1.00 (Declassified)

Body force and pressure measurements were obtained in the Langley 4- by 4-foot supersonic pressure tunnel for several positions of the blunt base, parabolic body with respect to the wing. Fairly good predictions of the trend and order of magnitude of the forces on the body due to the effect of the wing flow field were obtained from slender-body theory. Author

N63-12927 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN APPLICATION OF A NUMERICAL TECHNIQUE TO LIFTING-SURFACE THEORY FOR CALCULATION OF UNSTEADY AERODYNAMIC FORCES DUE TO CONTINUOUS SINUSOIDAL GUSTS ON SEVERAL WING PLANFORMS AT SUBSONIC SPEEDS

Harold N. Murrow, Kermit G. Pratt, and Joseph A. Drischler Washington, NASA, Feb. 1963 56 p 10 refs
(NASA TN D-1601) OTS: $1.50

The technique provides for the calculation of gust forces and forces due to motion and deformation on a consistent basis. Results presented include the following complex quantities: (a) spanwise distribution of section lift coefficient, (b) total lift coefficient, and (c) total pitching-moment coefficient. Calculations were made for two subsonic Mach numbers and a reduced-frequency range of 0 to 1.0. Author

N63-12978 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION OF PRESSURES AND HINGE MOMENTS ON A SWEPTBACK T-MOUNTED HORIZONTAL TAIL AT MACH NUMBERS FROM 0.60 TO 1.075

Robert J. Ward and Joseph M. Hallissy, Jr. Washington, NASA, Nov. 1959 35 p 3 refs
(NASA TM X-61) OTS: $1.00 (Declassified)

An investigation was conducted in the Langley 16-foot transonic tunnel and the 8-foot transonic pressure tunnel of a sweptback T-mounted horizontal tail with various modifications at Mach numbers from 0.60 to 1.075 and for wing angles of attack from −4° to 14°. The basic horizontal tail had an aspect ratio of 3.5, an NACA 63A009 airfoil section, and a sweep of the quarter-chord line of 40°. This horizontal tail was mounted on the sweptback vertical tail of a seaplane model designed for transonic speeds. Pressure, force, and hinge-moment data are presented on the basic horizontal tail, but no pressure data were obtained on the modifications. Some sideslip data are also presented. A hinge-moment couple is shown to exist at zero tail loading because of interference of the vertical tail, bullet fairing, and fuselage base on the horizontal tail. Transonic stabilizer hinge moments several times greater than at subsonic speeds resulted from the shift of the aerodynamic center in the basic stabilizer. A thin delta tail eliminated interference effects and delayed but did not reduce the aerodynamic-center shift. Variation of the stabilizer hinge-moment level through use of elevator deflection, bullet-mounted flaps, or other camber-changing devices is shown to minimize the adverse effect of the aerodynamic-center shift. Author

N63-12982 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF TWIST AND CAMBER AND THICKNESS ON THE AERODYNAMIC CHARACTERISTICS OF A 75° SWEPT ARROW WING AT A MACH NUMBER OF 2.91

James N. Mueller and John E. Grimaud Washington, NASA, Dec. 1959 68 p 27 refs
(NASA TM X-138) (Declassified)

Four wing-alone models having an aspect ratio of 1.79 and a taper ratio of 0 and mounted to low-drag stings were used in the investigation, i.e., two twisted and cambered wings of different thicknesses, and two nontwisted, noncambered wings with the same thickness distribution as the twisted and cambered wings. The tests were made at a Reynolds number of 1.50×10^6 with and without fixed transition. Lift, drag, and pitching-moment coefficients were measured over an angle-of-attack range of −2° to 8°. Author

N63-13009 Technology, Inc., Dayton, Ohio

STUDY OF PARACHUTE SCALE EFFECTS [Final] Technical Documentary Report [Feb. 15 - Nov. 15, 1962]

William B. Walcott Wright-Patterson AFB, Ohio, Flight Accessories Lab., Jan. 1963 79 p 158 refs
(Contract AF 33(657)-8073)
(ASD-TDR-62-1023)

A study was conducted to determine the effects of changing scale upon drag coefficient, filling time, peak opening force, and stability for single, unreefed textile parachute canopies. The investigation was confined to Flat Circular, Extended Skirt, Ringslot, Ribless Guide Surface, Circular Flat Ribbon, and Conical Ribbon parachutes operating in the subsonic flow regime at altitudes below 20,000 feet. As an integral part of the study, a survey of the existing literature and test data, compilation of all pertinent data, and recommendations for future experimental investigations were made. Scaling equations with associated 95-percent confidence intervals were developed for the drag coefficient of the Flat Circular and Extended Skirt parachutes through the use of a multiple regression analysis which indicates the significant variables and their functional forms. Because the available data was poorly distributed, the equations will have to be used circumspectly to avoid misleading conclusions. Author

N63-13100 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE MODEL WITH TWO HIGH DISK-LOADING FANS MOUNTED IN THE WING

David H. Hickey and Leo P. Hall Washington, NASA, Feb. 1963 79 p 6 refs
(NASA TN D-1650) OTS: $2.00

The aerodynamic characteristics and performance of direct lifting fans mounted in both wing panels of a large-scale VTOL airplane were investigated during low-speed flight. The model had a shoulder-mounted wing-of-aspect ratio 3.5. The effects on longitudinal characteristics of fan operation, of thrust control by means of deflecting the fan efflux, and of trailing-edge flap deflection were studied. Control power available from throttling the fans with differential

exit louver deflection was also determined. The lifting-fan performance, three-component longitudinal characteristics, wing-surface static-pressure distributions, and downwash at the horizontal tail are included. Author

N63-13114 National Advisory Committee for Aeronautics. Ames Aeronautical Lab., Moffett Field, Calif.

AERODYNAMIC CHARACTERISTICS OF TWO RECTANGULAR-PLAN-FORM, ALL-MOVABLE CONTROLS IN COMBINATION WITH A SLENDER BODY OF REVOLUTION AT MACH NUMBERS FROM 3.00 TO 6.25

Thomas J. Wong and Hermilo R. Gloria Washington, NACA, Dec. 28, 1955 40 p 17 refs
(NACA RM A55J07) OTS: $3.60 ph, $1.40 mf

Results of force and moment tests at Mach numbers from 3.00 to 6.25 on two rectangular-planform, all-movable controls in combination with a slender body of revolution are presented and compared with the predictions of theory. The controls had aspect ratios of 4/9 and 1 (for exposed panels joined together) and ratios of body radius to wing semispan of 0.6 and 0.4, respectively. The body had a fineness ratio of 12. The models were tested at angles of attack up to 25°, control deflection angles from −30° to +30°, and Reynolds numbers based on control chord from 0.23 million to 1.2 million, depending on test Mach number. The results showed that lift variations with angle of attack were somewhat nonlinear for both control-body combinations tested. However, linearized wing-body interference theory when combined with experimentally determined characteristics of the body gave, for the most part, adequate predictions of lift, drag, and pitching-moment coefficients of the control-body combinations. Control hinge moments were linear only at small angles of attack and control deflection. Hinge-moment parameters were influenced to a large extent by the shape of the airfoil section and, hence, were not well predicted by linear theory. A method which considers this effect, the slender-airfoil shock-expansion method, provided better estimates of these parameters. Author

N63-13181 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE BENDING-MOMENT DISTRIBUTION OF CAMBERED-SPAN WING SYSTEMS HAVING MINIMUM INDUCED DRAG

Clarence D. Cone, Jr. Washington, NASA, Mar. 1963 32 p 2 refs
(NASA TN D-1505) OTS: $1.00

The basic integral equations for determining the bending-moment distributions of optimally-loaded cambered-span wing systems are derived and applied to the calculation of the moment distributions for the families of circular-arc and semiellipse camber forms. The effects of the type and amount of camber on the moment distribution are investigated, and it is shown that spanwise camber results in an appreciable increase in the local bending moment near the tips, as compared with that of flat wings furnishing equal lift. The quantitative relation between the magnitude of the bending moment and the induced-drag efficiency of cambered-span wings is developed. A simple analysis is carried out to establish the wing structural requirements dictated by the bending-moment distribution, and a procedure is outlined for determining the optimum chord distribution of the wing for obtaining minimum profile drag. Author

N63-13185 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF BLAST LOADING ON AN AIRFOIL IN MACH NUMBER 0.7 AIRFLOW WITH INITIAL ANGLE-OF-ATTACK CHANGE OF 20°

Harold B. Pierce and James C. Manning Washington, NASA, Feb. 1963 38 p 11 refs
(NASA TN D-1603) OTS: $1.00

An experimental investigation has been completed on the blast loading imposed on an airfoil in Mach number 0.7 flow by a blast wave which caused an initial angle-of-attack change of approximately 20°. Pressure distributions along one chord of the airfoil at intervals of 0.1 millisecond show the initial diffraction of the blast wave around the airfoil while subsequent distributions at intervals of 0.5 millisecond show the progress along the chord of a leading-edge vortex formed in the diffraction period. Normal-force coefficients obtained from the blast-test pressure distributions were substantially greater than those from wind-tunnel tests for a period of 10 milliseconds after blast-wave arrival. The investigation, the first conducted at the NASA Ground Blast Apparatus, consisted of two tests made under essentially the same conditions. Author

N63-13216 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TRANSONIC AERODYNAMIC CHARACTERISTICS OF A LATERAL CONTROL EMPLOYING ROTATABLE AIRFOILS MOUNTED VERTICALLY AT THE WING TIPS OF A 45° SWEPTBACK WING, FUSELAGE, AND TAIL COMBINATION

John A. Axelson Washington, NASA, June 1959 50 p 7 refs
(NASA Memo 6-9-59A) OTS: $1.25 (Declassified)

An aerodynamic lateral control consisting of small, rotatable airfoils mounted vertically at the wing tips has been investigated over a Mach number range from 0.40 to 1.16 on a 45° sweptback wing, body, and tail combination. The wing had an aspect ratio of 4.00, a taper ratio of 0.64, an NACA 64A010 section along chords normal to the quarter-chord line, and a span of 5.10 feet. The control airfoils were 3 inches high and were mounted on the top and bottom of small wing tip bodies. Two different types of controls were investigated, large (or single) controls whose chords were approximately 75 percent of the wing tip chord, and multiple controls, consisting of three tandem-mounted airfoils whose combined chords comprised approximately 75 percent of the wing tip chord. The controls were effective over the test range of Mach numbers and angles of attack, produced no significant effects on the longitudinal aerodynamic characteristics except for a moderate drag increase, produced generally small or no yawing moments with the rolling moments, and contributed significantly to the directional stability of the model. Author

N63-13221 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

WIND-TUNNEL TESTS OF TWO VTOL PROPELLERS IN DESCENT

Paul F. Yaggy and Kenneth W. Mort Washington, NASA, Mar. 1963 26 p 1 ref
(NASA TN D-1766) OTS: $ 0.75

The vertical or near-vertical descent of propeller-driven, VTOL aircraft causes the propellers to experience negative inflow angles. As the rate of descent is increased from zero, the propeller passes through the turbulent vortex-ring state. Tests of a rigid and a flapping propeller were made at various rates of descent from 0 to 6,000 feet per minute to determine the effects of operation in the vortex-ring state upon the thrust force produced by the propellers. The tests covered a disc loading range from 0 to 36 pounds per square foot. The results of these tests showed that thrust oscillations as large as ±75 percent of the steady-state thrust occurred, and that the average period of the oscillations was about 0.2 second, apparently independent of other test parameters. Author

N63-13269 Stanford U., Calif.

VERIFICATION AND EXPLANATION OF THE CONTROLLABILITY OF JET FLAP THRUST Final Report

George Alexander Tsongas Oct. 1962 105 p 13 refs
(Sponsored by Boeing Co. and Convair)
(SUDAER-138)

Since the practical use of "air" jet flaps for reducing the approach and landing speeds of airplanes depends largely upon

whether the resulting forward jet-flap thrust can be suppressed, experiments were conducted to see if this type of thrust control was possible and if the mechanism of such control could be identified. Devices which were thought to have potential merit as jet thrust suppressors were investigated by determining the forces experienced by appropriately modified forms of a jet-flapped model wing under the conditions of two-dimensional flow. Results indicated that the extent of thrust control provided by large deflections of a simple jet flap was not augmented by any of the auxiliary devices tested. However, force tests showed that jet-flap thrust recovery in two-dimensional flow can be controlled and practically nullified, without sacrifice of lift, by the use of large flap deflections (95°). Flow visualization studies showed that the aerodynamic phenomenon which enables such control is the development, with large flap deflections, of a rapidly diverging, low-energy wake which lies immediately behind and above the deflected jet and is almost free of a large-scale turbulence. B.J.C.

04 AIRCRAFT

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

N63-12883 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A CRITICAL STUDY OF DELTA-WING CONFIGURATIONS FOR THE SUPERSONIC TRANSPORT APPLICATION

J. Lloyd Jones, Jr., Lynn W. Hunton, Thomas J. Gregory, and Walter P. Nelms, Jr. N.Y., Inst. of the Aerospace Sciences [1963] 16 p 5 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963

(IAS Paper-63-5) IAS: $0.50 members, $1.00 nonmembers

A critical study is made of delta-wing configurations for possible supersonic transport application. It is shown that a severe penalty to airplane performance capability will be incurred if oversized engines are used to compensate for lack of definition of the transonic thrust-drag margin. Results of wind-tunnel tests and piloted simulator studies indicate that the very low aerodynamic damping characteristic of transport aircraft will require the use of damping augmentation about all three aerodynamic axes. The low values of wing loading at takeoff, indicated to be optimum for a delta-wing transport designed to cruise at a Mach number of 3 for transcontinental or intercontinental ranges, reduce the severity of the problem of providing satisfactory landing characteristics. Results to date from wind-tunnel tests of high-lift devices show that satisfactory landing characteristics can be provided for a delta-wing transport. J.R.C.

N63-12889 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CHARACTERISTICS OF AIRCRAFT WITH LIFTING-FAN PROPULSION SYSTEMS FOR V/STOL

David Hickey and Robert H. Goldsmith (General Electric Co.) N.Y., Inst. of the Aerospace Sciences, [1963] 32 p 12 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963

(IAS Paper-63-27) IAS: $0.50 members, $1.00 nonmembers

Results from wind-tunnel tests of several large-scale lifting-fan models are analyzed. Both fan-in-fuselage and fan-in-wing configurations are considered. In contrast to small-scale studies which have indicated a lift reduction with forward speed, the large-scale configurations tested had a sizable positive induced lift. It is shown that fan-in wing aircraft can be designed to reduce the variation of pitching moment with airspeed in transition flight so that control power requirements to trim the pitching moment are less severe than for a heavily flapped wing. Rudimentary methods for estimating induced lift and the thrust-drag relationship are shown to give accurate and rapid means for estimating performance of lift-fan aircraft. The induced lift computation takes into account varying wing size and geometry. An empirical method for estimating the pitching-moment variation with airspeed is suggested, and means to minimize these moments is discussed. Results of a dynamic analysis of transition obtained from an analog computer program are presented. It is shown that rapid, controlled accelerations and decelerations in transition are possible. The rates of descent at low speed were large. Conversion from fan-supported to wing-supported flight was accomplished with no altitude loss. Author

N63-12917 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INTERFERENCE EFFECTS AT TRANSONIC SPEEDS OF JETS EXHAUSTING FROM THE HULL STEP OF A MODEL OF A LARGE, WATER-BASED AIRPLANE

Beverly Z. Henry, Jr. Washington, NASA, Jan. 1960 35 p 5 refs (NASA TM X-218) OTS: $1.00 (Declassified)

Tests have been conducted at transonic speeds to determine the interference effects of two sonic jets exhausting through the hull step of a 1/58-scale model of a large, water-based airplane. The tests were conducted using hydrogen peroxide decomposition units for jet simulation at jet total-pressure ratios up to 7.3. Lift, drag, and pitching-moment coefficients as well as hull-step and base-pressure coefficients were measured. Results indicated that operation of the jets induced only minor changes in the aerodynamic coefficients and in static stability. Author

N63-12953 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF GROSS LOAD AND VARIOUS BOW MODIFICATIONS ON THE HYDRODYNAMIC CHARACTERISTICS OF A HIGH-SUBSONIC MINE-LAYING SEAPLANE

Walter J. Kapryan Washington, NASA, Jan. 1960 35 p 1 ref (NASA TM X-71) OTS: $1.00 (Declassified)

Results indicate that the basic configuration has marginal longitudinal stability. Increase in bow length eliminates a false hump in the smooth-water resistance of the basic configuration but does not otherwise materially affect the resistance in either smooth or rough water. For operation in rough water, the basic configuration is limited to small waves by excessive spray. Increases in bow length raise the spray boundary to higher wave heights. The effects of gross weight and the manner of increasing bow length on the spray boundary are small. The hump resistance in rough water increases with wave height but is relatively unaffected by bow length. Author

N63-12974 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION OF THE STATIC STABILITY OF A 1/56-SCALE MODEL OF THE X-1E AIRPLANE AT MACH NUMBERS OF 2.37, 2.98, AND 4.01

Fred M. Smith Washington, NASA, Aug. 1959 121 p 9 refs (NASA TM X-5) OTS: $2.50 (Declassified)

Normal force, pitching moment, rolling moment, yawing moment, and side force were obtained in the Langley high Mach number jet. The investigation was made to determine the static stability characteristics caused by adding various fin arrangements to the base of the

airplane or by adding a pair of strakes to the forebody at combined angles of attack and sideslip of -9° to 15° and -1° to 5°, respectively. A limited comparison was made between preliminary flight-test data and wind-tunnel data for the airplane with no directional-stability-improvement devices. Author

N63-12977 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT INVESTIGATION OF THE EFFECT OF DISTRIBUTED ROUGHNESS ON SKIN DRAG OF A FULL-SCALE AIRPLANE

Edwin J. Saltzman Washington, NASA, Sept. 1959 28 p 9 refs (NASA TM X-36) OTS:$0.75 (Declassified)

The change in drag caused by the addition of two sizes of distributed sand-type roughness to the wings and tail surfaces of a delta-wing airplane has been measured at Mach numbers near 0.8 and 1.1. The largest roughness, 0.006-inch mean effective diameter, caused an increase in drag comparable to the increase predicted by the low-speed drag law for a rough plate. The increase in drag caused by the addition of the smallest roughness, 0.002-inch mean effective diameter, was less than half that predicted by the low-speed drag law for a rough plate. Author

N63-12979 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF A VARIABLE-INCIDENCE DELTA-WING CANARD MODEL WITH HIGH-LIFT CANARD SURFACES

Clarence D. Cone, Jr. Washington, NASA, Sept. 1959 72 p 4 refs (NASA TM X-72) OTS: $2.00 (Declassified)

An investigation was conducted in the Langley full-scale tunnel to determine the low-speed longitudinal and lateral stability and control characteristics of a variable-incidence delta-wing canard model using high-lift devices on the canards. The basic data are presented along with summary plots showing the maximum trim lift coefficient as a function of center-of-gravity position. Author

N63-12994 Walker Associates, Inc. (Norman K.), Bethesda, Md.

THE EFFECT OF THE VERTICAL POSITION OF THE CENTER OF GRAVITY ON THE STABILITY OF AN ANNULAR JET GROUND EFFECT MACHINE

Norman K. Walker and Alastair Anthony Ft. Eustis, Va., Army Transportation Research Command, Dec. 1962 62 p 4 refs
(Contract DA-44-177-TC-830)
(TCREC-TR-62-101)

Lift, sideforce, and rolling moment were measured on a powered model thin-annular jet GEM hovering with the motion restricted to the transverse plane. The lift vector is shown to remain nearly normal to the base when the machine is rolled and so the stability in roll is unaffected by the height of the CG relative to the base, as long as the machine is clear of any obstacle which could exert large lateral forces on it. As a practical check the machine was flown free with the CG in positions one third, two thirds, and finally one whole beam above the base, without affecting the dynamical stability. Author

N63-12995 Ryan Aeronautical Co., San Diego, Calif.

FLEXIBLE WING CARGO GLIDERS. VOLUME I Final Program Summary Report

E. Rouzee Givens Sept. 15, 1962 59 p For Volume II see N63-12996 07-04
(Contract DA 44-177-TC-779)
(TCREC-TR-62-3A; Ryan Rept. 61B114(A))

Four basic configurations of the Flexible Wing Cargo Glider were established. All four were of the same design family, but with payload capacities of 250, 1,000, 4,000, and 8,000 pounds each. Specifications MIL-A-8861 and 8862 were used as a guide for design criteria for each of the configurations. To the extent practicable, the high standards for safety of flight for manned flight vehicles were maintained. Author

N63-12996 Ryan Aeronautical Co., San Diego, Calif.

FLEXIBLE WING CARGO GLIDERS. DESIGN CRITERIA AND AERODYNAMICS, VOLUME II

E. Rouzee Givens Sept. 15, 1962 279 p 22 refs For Volume I see N63-12995 07-04
(Contract DA 44-177-TC-779)
(TREC-TR-62-3B; Ryan Rept. 61B114(A))

Program aim was to determine the feasibility of the development of cargo gliders using the Rogallo-type Flexible Membrane Wing. Designs are presented for configurations with payload capacities of 250, 1,000, 4,000, and 8,000 pounds each. Design and technical analysis of each configuration is presented. Requirements for the modification of standard air and rotor craft to be used for towing or air launching of the gliders are presented. Author

N63-13021 Beech Aircraft Corp., Wichita, Kan.

PROTOTYPE DEVELOPMENT MODEL 385 AIR REFUELING STORE Interim Report No. 29, 1 Oct. 1962-31 Oct. 1962

C. V. Lassman Nov. 9, 1962 6 p
(Contract NOw-60-0060-c)
(Engineering Rept. 4556)

In the continuing development of the Beech Model 385 Air Refueling Store, progress has been achieved on value engineering and prototype testing. Detail design for the value analysis configuration is nearing completion. A ground resonance test of the prototype store on the F4H airplane has been completed; results indicate that the installation is suitable for flight. Preparations are in process for flight tests on the F4H. Author

N63-13051 Republic Aviation Corp., Farmingdale, N.Y.

VARIABLE SWEEP WING PLUS V/STOL—A NEW ERA IN AIRCRAFT DESIGN. PART I—AERODYNAMIC DESIGN ASPECTS

J. Cangelosi Dec. 12, 1962 37 p 1 ref Presented at the New York Acad. of Sci. Conf. on VTOL Aircraft, Dec. 12, 1962
(RAC-1012; ARD-976-100)

This discussion describes, in aerodynamic terms, how versatility is obtained in a variable sweep wing. A typical and practical variable sweep wing design with VTOL capability is presented for purposes of discussion. The range of geometric properties, together with the resulting range of aerodynamic properties, is given for this design. Values of wing span, wing chord-thickness ratio and wing aspect ratio, as these geometric parameters vary with wing sweep, are presented. Also presented are the resulting values of drag, lift, and lift-to-drag ratio, as these aerodynamic parameters vary with wing sweep. Comparisons are made with the aerodynamic properties of a fixed wing design to show the versatility of the variable sweep wing concept or, conversely, to show the compromises that must be made in the fixed wing approach. To further illustrate the versatility of the variable sweep wing, several airplane missions are discussed. The ability to accomplish the various missions in an optimum manner, in a single aircraft, are pointed out. Comparisons of mission performance with fixed and sweep wing designs are made. The variable sweep wing design is shown to have a multimission capability. Comments on stability and control characteristics of variable sweep wing designs are made and some results are given. The importance of variable sweep in minimizing airplane response in a turbulent atmosphere environment is also discussed and results are given. Author

N63-13107 National Advisory Committee for Aeronautics. Ames Aeronautical Lab., Moffett Field, Calif.

WIND-TUNNEL TESTS OF THE STATIC LONGITUDINAL CHARACTERISTICS AT LOW SPEED OF A SWEPT-WING AIRPLANE WITH BLOWING FLAPS AND LEADING-EDGE SLATS

Harry A. James and Ralph L. Maki Washington, NACA, July 5, 1957 45 p 11 refs
(NACA RM A57D11) OTS: $4.60 ph, $1.55 mf (Declassified)

A wind-tunnel investigation of a high-wing airplane having an aspect ratio 6.75 wing with approximately 36° of sweepback was conducted to determine the lift effectiveness obtainable with trailing-edge blowing flaps in combination with leading-edge slats. Close to theoretical flap effectiveness was obtained with blowing flaps deflected 45°, 55°, and 65° at low angles of attack. Flap effectiveness and stability were maintained to high angles of attack by control of leading-edge flow separation with slats. Maximum lift was a function of leading-edge configuration, trailing-edge flap deflection angle, and amount of boundary-layer control applied. With a 55° trailing-edge flap, and with a full-span simulated 24° slat, maximum lift coefficient was increased from 2.20 boundary-layer control off to 2.54 with a momentum coefficient of 0.012 and further increased to 2.69 with a momentum coefficient of 0.032. An evaluation of the results obtained in terms of estimated takeoff and landing performance indicated reductions in distance over a 50-foot obstacle amounting to 35 percent on landing and 13 to 18 percent on takeoff. Author

N63-13180 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL TESTS OF A CIRCULAR PLANFORM AIRCRAFT WITH A PERIPHERAL JET FOR LIFT, THRUST, AND CONTROL

Richard K. Greif and William H. Tolhurst, Jr. Washington, NASA, Feb. 1963 97 p 7 refs
(NASA TN D-1432) OTS: $2.25

Full-scale tests have been conducted in the Ames 40- by 80-foot wind tunnel to determine the performance, stability, and control characteristics of a research aircraft having a circular planform and employing a peripheral jet for lift, thrust, and control. The aircraft was 18 feet in diameter and 18 percent thick. Propulsion was provided by a 5-foot-diameter rotor which took in air through the wing upper surface and drove it through internal ducting to a peripheral nozzle designed to provide thrust vector control. Six-component aerodynamic data and propulsion-system flow data were obtained at various angles of attack over a range of jet-momentum coefficients from 0 to 3.4. Flight characteristics in the cruise configuration were determined at altitudes ranging from 12 feet 7 inches to 2 feet 8 inches. Transition-flight characteristics were studied only at the lowest ground height. Some effects of forward speed on rotor performance were also investigated. Author

N63-13251 National Aeronautics and Space Administration, Washington, D.C.

DEVELOPMENT OF SOUNDING ROCKETS IN JAPAN

Hideo Itokawa, et al Mar. 1963 159 p refs Transl. of articles from Seisan-Kenkyu (Tokyo), v. 12, no. 12, 1960
(NASA TT F-87) OTS: $3.00

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V. THE CONSTRUCTION OF THE KAPPA ROCKETS, WITH SPECIAL CONSIDERATION OF THE K-8 K. Mori p 110-121 (See N63-13256 07-34)
VI. AERODYNAMICS OF THE KAPPA ROCKET A. Tamaki p 122-132 17 refs (See N63-13257 07-02)
VII. LOW NOISE AMPLIFIER FOR RADAR S. Saito and J. Hamazaki p 133-141 2 refs (See N63-13258 07-09)
VIII. OPTICAL TRACKING OF ROCKETS T. Maruyasu and T. Uemura p 142-148 (See N63-13259 07-08)
IX. SOUNDING ROCKET MANAGEMENT AND ADMINISTRATION J. Shimomura p 149-156 (See N63-13260 07-01)

N63-13252 Tokyo U. Inst. of Industrial Science (Japan)

FROM THE PENCIL ROCKET TO THE KAPPA-8

Hideo Itokawa *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 28-54 (See N63-13251 07-04) OTS: $3.00

The development of sounding rockets in Japan is reviewed beginning with the Pencil rocket in 1955 and progressing through the Kappa-8 rocket in 1959. These are solid propellant rockets ranging in size from 23 cm to 10,032 cm. The problems occurring during this development period are discussed. R.C.M.

N63-13253 Tokyo U. Inst. of Industrial Science (Japan)

THE ROCKOON

Osamu Hirao and Tomo Okamoto *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 55-74 (See N63-13251 07-04) OTS: $3.00

The program to launch sounding rockets from balloons (rockoon) is outlined, and the problems encountered are discussed. While no actual flights were made, dummy launching tests have shown that under favorable climatic conditions a rockoon can be launched safely and reliably. R.C.M.

N63-13299 Bell Helicopter Co., Fort Worth, Tex.

DEMONSTRATION PLANNING AND PROGRESS REPORT—HU-1E HELICOPTER

T. L. Hoffman Nov. 15, 1962 33 p 19 refs
(Contract AF 33(657)-9777)
(Rept. 204-099-036)

Flight-test requirements for the HU-IE Helicopter are discussed. The report outlines specific areas where test requirements have been and have not been met. B.J.C.

05 ASTRONOMY AND ASTROPHYSICS

Includes: celestial mechanics; and radioastronomy.

For related information see: 12 Geophysics; and 29 Space Sciences.

N63-12879 High Altitude Observatory, Boulder, Colo.

SOLAR PHYSICS

Harold Zirin N.Y., Inst. of the Aerospace Sciences [1963] 6 p Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(NASA Contract NsG-92-60)
(IAS Paper-63-1) IAS: $0.50 members, $1.00 nonmembers

A review of solar physics includes the interior structure of the sun, the photosphere, the chromosphere, the solar corona, and solar flares. I.v.L.

N63-13022 Academy of Sciences (USSR). Inst. of Radio Tech. and Electronics, Moscow

RADIO LOCATION OF THE PLANET VENUS IN APRIL 1961, IN THE SOVIET UNION Scientific Report

V. A. Kotel'nikov, V. M. Dubrovein, M. D. Kislik, E. B. Korenberg, V. P. Minashin, V. A. Morozov, N. J. Nikitokii, G. M. Petrov, O. N. Rzhiga, and A. M. Shakhovskoi Transl. by Marjorie Ketner Feitis 1961 69 p 7 refs

Radio location observations of the planet Venus in the Soviet Union in April 1961 were investigated. The purpose was to make a more accurate determination of the astronomical unit (the mean distance from the Earth to the Sun), to estimate the period of rotation for Venus, and to obtain data on its surface. Results indicate that: (1) The astronomical unit equals 149,599,300 km with a maximum error of ±2000 km. (2) The spectrum lines of the signal from Venus were extended after reflection. The narrow band component of the signal corresponded to less than a 4 cycle extension of the lines, and its intensity barely changed throughout all the observation days (18, 19, 20, 21, 23, 24, 25, and 26 April). The wide band component of the signal corresponded to an extension of the lines up to 400 cycles and more. Its intensity varied greatly from day to day. The energy of the wide band component was commensurate with the energy of the narrow band component. (3) The reflection coefficient, determined from the narrow band component, equals 8 percent (with respect to an ideal, conducting sphere of the same size). (4) It is impossible to make a reliable estimate of the rotation period of Venus at the present time, on the basis of the spectra obtained from the reflected signals. I.v.L.

N63-13042 Harvard Coll. Observatory, Cambridge, Mass.

TEMPERATURE EFFECTS IN PHOTOMULTIPLIERS AND ASTRONOMICAL PHOTOMETRY

Andrew T. Young Repr. from Applied Optics, v. 2, no. 1, Jan. 1963 p 51-60 21 refs

(NASA Grant NsG-64-60)

Temperature coefficients are reported for photomultiplier tube types used in astronomy. For 1% stability of gain and color response, temperature regulation of 1°C or better is generally required. This is nearly an order of magnitude better than what is usually achieved at the telescope, but careful use of a well-designed cold box should make 1°C temperature stability possible. For maximum stability and reproducibility, ordinary blue-sensitive tubes should be avoided at wavelengths longer than 5000 Å, and trialkali cathodes should not be used beyond 6500 Å. Author

N63-13170 Yerkes Observatory, Williams Bay, Wis.

BAND-HEAD WAVELENGTHS OF C_2, CH, CN, CO, NH, NO, O_2, OH, AND THEIR IONS Research Paper No. 6

L. Wallace Repr. from Astrophys. J., Suppl. Ser., v. 7, no. 68, Oct. 1962 p 165-290

(NASA Grant Nsg-118-61; Contract AF 19(604)-3044)

Band-head wavelengths are presented for C_2, CH, CN, CO, NH, NO, O_2, OH, and their ions to facilitate the interpretation of the ultraviolet spectra of the dayglow, twilight, and aurorae of the Earth, Mars, and Venus. Wavelength tables are organized according to the wavelength regions involved and the degradation of the bands. J.R.C.

N63-13215 National Aeronautics and Space Administration, Washington, D.C.

OBSERVATORY REPORTS

Nancy G. Roman Repr. from Astron. J., v. 67, no. 9, Nov. 1962 p 655-658 1 ref

Studies performed under the NASA Geophysics and Astronomy Programs are reviewed. These include the observations made by the first Orbiting Solar Observatory, by Glenn and Carpenter during their orbital flights, by sounding rockets, and by astronomical observatories. Theoretical and laboratory studies are also included. R.C.M.

06 AUXILIARY SYSTEMS

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic, and electrical control systems and actuators; and inverters.

For primary propulsion systems see: 27 Propulsion

For related information see: 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

N63-12875

INVESTIGATIONS ON LONG-STRETCHING BODY RESTRAINTS

Bertil Aldman (Bromma, Sweden) *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 355-360 3 refs (See N63-12844 07-16) NAS: $3.00

The use of long-stretching straps for restraint in an automobile where the space is so limited that upper torso restraint is desired is discussed. The use of such straps means that even with very high rate-of-onset of deceleration for the automobile, the rate-of-onset of deceleration for the restrained body will be governed by the stretching properties of the straps. Neither the time delay nor the deceleration pattern of the automobile will be of much influence if if the stretching properties of the restraint are such that the deceleration of the occupant is tolerable under the worst possible conditions. I.v.L.

N63-12948 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

POWER INPUT TO A SMALL FLAT PLATE FROM A DIFFUSELY RADIATING SPHERE WITH APPLICATION TO EARTH SATELLITES: THE SPINNING PLATE

Fred G. Cunningham Washington, NASA, Feb. 1963 46 p 1 ref (NASA TN D-1545) OTS: $1.25

A general derivation is presented for the radiation from a uniformly radiating sphere incident on a small flat plate, spinning about an axis not coincident with its normal. The results are presented as a function of the separation of the bodies, the orientation of the plate, and the orientation of the spin axis. In addition, a series of curves is given which represents the power input from earth radiation to one side of a spinning flat plate (averaged over a spin period) for a range of altitude from 200 km to 32,000 km. These curves are based upon the assumption that the earth is a uniform diffuse emitter radiating as a blackbody at a temperature of 250°K. Author

N63-13219 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYTICAL STUDY OF A SIMPLE ATTITUDE CONTROL SYSTEM FOR A FINNED VEHICLE

Jack E. Harris Washington, NASA, Mar. 1963 35 p 4 refs (NASA TN D-1608) OTS: $1.00

An analytical study was made of a finned-vehicle first-stage attitude control system incorporating an attitude error feedback signal and simple forward-loop compensation. The effects of various compensation networks on system performance are compared for flight conditions, ranging from dynamic pressures of 100 lb/sq ft to 3,200 lb/sq ft. A simple tandem compensation network that enables the control system to obtain good response characteristics to attitude command inputs and to maintain satisfactory path control when subjected to wind disturbance is discussed. Author

07 CHEMISTRY

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis.

For related information see: 18 Materials, Metallic; 19 Materials, Non-metallic; and 26 Propellants and Combustion.

N63-12878 Armour Research Foundation, Chicago, Ill.
RESEARCH ON CHEMISTRY OF O_3F_2 AND O_2F_2, JULY 1 THROUGH SEPTEMBER 30, 1962 Technical Summary Report
Irvine J. Solomon Nov. 8, 1962 15 p 2 refs
(Contract AF 49(638)-1175; ARPA Order 350-62)
(ARF 3227-1)

The purpose of this program is to study the reactions of O_3F_2 and O_2F_2 with inorganic compounds. Efficient methods were developed for the preparation of O_3F_2 and O_2F_2, the decomposition of the two compounds was studied, and the reaction chemistry of O_2F_2 with alkali metals, alkaline-earth metals, and sulfur and phosphorus was investigated. As part of the program O_2BF_4, an interesting, new, white, solid compound, is also being investigated. Decomposition studies have shown that O_2F_2 is unstable above −160° C. The reactions of sodium, lithium, and potassium with O_2F_2 are surprisingly mild. The products of these reactions are currently being identified. Calcium shows no sign of reaction with O_2F_2. Sulfur reacts vigorously with O_2F_2 to yield SOF_4, SO_2F_2, $(SO_3)_n$, and other products which are now being characterized. Phosphorus reacts with O_2F_2 even at −196° C; the products of the reaction are being identified. Infrared spectra, which were obtained for O_2F_2 and O_2BF_4, are being analyzed. Author

N63-12882 National Aeronautics and Space Administration, Washington, D. C.
CHEMISTRY OF THE UPPER ATMOSPHERE
Robert F. Fellows N.Y., Inst of the Aerospace Sciences [1963] 8 p 13 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(IAS Paper-63-4) IAS: $0.50 members, $1.00 nonmembers

A study is made of the main constituents of the upper atmosphere (oxygen and nitrogen). The direct measurements and the use of chemical reagents for studying the composition, reactions, and kinetics of the upper atmosphere are based upon spectroscopic studies of the radiation emitted from the reactions occurring in the upper atmosphere. The aurora and the airglow are two features that can be studied spectroscopically to obtain further information on the atmosphere. The aurorae are much more intense than the airglow but are subject to well-known geographical restrictions that do not apply to the airglow. The airglow is indicative of reactions occurring in which radiations in the ultraviolet, visible, or infrared are emitted. J.R.C.

N63-12940 California U., Berkeley. Lawrence Radiation Lab.
BIBLIOGRAPHY FOR HINDERED INTERNAL ROTATION AND MICROWAVE SPECTROSCOPY
D. R. Herschbach Oct. 1962 33 p 201 refs
(Contract W-7405-eng-48)
(UCRL-10404) OTS: $0.75

Results of microwave studies on internal rotation are summarized in tabular form. Also, a bibliography covering these studies is given. The tables present the molecular parameters derived from the spectra of all molecules studied up to September, 1962. R.C.M.

N63-12941 California U., Berkeley. Lawrence Radiation Lab.
TABLE OF KINETIC ENERGY VS. MAGNETIC RIGIDITY FOR ELECTRONS
F. W. Breivogel and M. D. Holtz Oct. 23, 1962 166 p 1 ref
(Contract W-7405-eng-48)
(UCRL-10494) OTS: $2.75

A table is presented that consists of values of electron kinetic energies as a function of magnetic rigidity from $\beta_\rho = 0$ to $\beta_\rho = 26{,}000$ gauss-centimeters. The errors quoted are standard deviations, and a 95% confidence limit can be taken as approximately twice the quoted value. With the error limits as given, all values in the table above those for $\beta_\rho = 200$ are accurate to ±4 in the sixth significance figure. With twice the quoted error limits, the values are accurate to ±8 in the sixth significant figure. J.R.C.

N63-12955 Gt. Brit. Ministry of Aviation. Technical Information and Library Services, Mottingham
THE USE OF TRITIUM FOR THE DETERMINATION OF THE RELATIVE CONSTANTS OF THE ABSTRACTION RATES OF THE HYDROGEN ATOMS IN ORGANIC COMPOUNDS. THE COMPARATIVE REACTIVITY OF CARBON-HYDROGEN BONDS OF HYDRO-CARBONS IN RADICAL REACTIONS (PRIMENENIE TRITIYA DLYA OPREDELENIYA OTNOSITEL'NYKH KONSTANT SKOROSTEI OTRYRA ATOMOV VODORODA ORGANICHESKIKH SOEDINENII. OTNOSITEL'NAYA SPOSOBNOST UGLEROD-VODORODNYKH SVYAZEI UGLEVODORODOV V RADIKAL'NYKH REAKTSIYAKH)
V. L. Antonovskii, I. V. Berezin, and N. F. Kazanskaya Feb. 1962 10 p 11 refs Transl. from Izvest. Vyssh. Ucheb. Zaved., Khim. i Khim. Tekhnol. (Moscow), 5 (1), 1962 p 94-100
(TIL/T-5370)

The proposed method is described and applications by the use of labeled substances for determining abstraction rate constants are discussed. Other applications are the determination of the kinetic isotopic effects of hydrogen-tritium abstraction and determination of elementary constants of abstraction for hydrogen bonds in simple compounds. Author

N63-12989 Oak Ridge National Lab., Tenn.
DEVELOPMENT OF A RELIABLE LINE DISCONNECT FOR THE TRANSURANIUM PROCESSING FACILITY
T. S. Mackey Feb. 18, 1963 26 p
(Contract W-7405-eng-26)
(ORNL-3389) OTS: $0.75

Two disconnect designs were subjected to several severe tests in order to select the most suitable design. These performance tests demonstrated the superiority of the surface-seal concept over that of the line-seal concept and the reliability of this seal when subjected to misalignment forces, corrosive solutions, rough handling, and interchange of mating parts. Tests of Hastelloy C disconnects after heat treatment demonstrated the necessity for joining the disconnect to the process tubing by means other than welding. Several leak-tight joints were made by external mechanical swaging, by external electrical swaging (by the "Magniform" process developed by the General Dynamics Corporation) and by internal rolling. Hastelloy C disconnect samples machined to reasonable machine tolerance established the economic feasibility of the design. Author

N63-13024 Argonne National Lab., Ill.
CHEMICAL ENGINEERING DIVISION SUMMARY REPORT, JULY, AUGUST, SEPTEMBER, 1962
Stephen Lawroski, R. C. Vogel, and V. H. Munnecke [1962] 221 p 67 refs
(Contract W-31-109-eng-38)
(ANL-6596)

This report covers the following: chemical-metallurgical processing; fuel-cycle applications of volatility- and fluidization-techniques; calorimetry; reactor safety; energy conversion; and determination of nuclear constants. J.R.C.

N63-13029 Bureau of Mines. Helium Research Center, Amarillo, Tex.

VAPOR-LIQUID EQUILIBRIA FOR A HELIUM-NITROGEN-METHANE SYSTEM

W[illiam] J[efferson] Boone, Jr., Will E. De Vaney, and Lowell Stroud 1963 23 p 16 refs
(BM-RI-6178)

Experimental determinations were made of vapor-liquid equilibria data for a helium-nitrogen-methane system. A mixture composition was chosen to approximate the crude helium to be produced for conservation that will eventually be further refined to obtain pure helium. The equilibrium vapor-liquid data and equilibrium vaporization coefficients are presented. Author

N63-13037 Bureau of Mines. Albany Metallurgy Research Center, Ore.

LIST OF REFERENCES TO METAL-HALIDE VAPOR PRESSURES WITH BIBLIOGRAPHY

F. D. Stevenson and S. D. Hill 1963 39 p 307 refs
(BM-IC-8147)

This report on the thermodynamic properties of metal halides gives a tabulation of vapor pressure references for each of the metal halides for which actual experimental data are reported, and a bibliography of the citations. Metal halides and oxyhalides are listed by chemical formula and chemical name, based on the Stock system. To facilitate location of the references, a listing of the journal titles and their abbreviations follows the bibliography. J.R.C.

N63-13038 Bureau of Mines, Washington, D.C.

ANALYSIS OF HIGH-PURITY VANADIUM BY OPTICAL EMISSION SPECTROGRAPHY

Lloyd Carpenter and Kathleen Hazen 1963 20 p 16 refs
(BM-RI-6182)

Eighteen elements were determined spectrochemically in vanadium metal and its compounds in the general range of 1 to 1,000 ppm by means of spark-ignited unidirectional arc excitation. The samples were converted to vanadium pentoxide and combined with a mixture of graphite, lithium carbonate, and gallium oxide. For the molybdenum determination, the oxidized samples were mixed with sodium chloride and packed in copper electrodes. Average precision of the method was 15.6 percent relative standard deviation, and relative error was 4.4 percent. Author

N63-13075 California U., Riverside

MECHANISM STUDIES WITH BORONHYDRIDES Second Quarterly Technical Summary Report, September 27, 1962 to December 26, 1962

Frederick Hawthorne, Russell N. Grimes, Thomas Berry, and Peter F. Stokely [1962] 7 p 3 refs
(ARPA Order 366-62)

The mechanism of formation of the polyhedral $B_{10}H_{10}^{-2}$ ion from $B_{10}H_{12}(NEt_3)_2$ was investigated. A kinetic study of the reaction

$$B_{10}H_{12}(NEt_3)_2 + 2NEt_3 \rightarrow B_{10}H_{10}^{-2} + 2\overset{+}{N}HEt_3 + 2NEt_3$$

was initiated in acetonitrile at 100° C. Preliminary results obtained indicate a half-life of ca. 200 minutes with a triethylamine concentration of 0.10M. The reaction of the triphenyl carbonium ion with the $B_{10}H_{10}^{-2}$ ion was examined on a preparative scale in a variety of organic solvents. In a representative run, a 100-percent excess of $(Et_3\ NH)_2\ B_{10}H_{10}$ dissolved in dry acetonitrile was treated with two molecular equivalents of solid triphenylmethyl chloride. The blue product formed was immediately accompanied by a mild exotherm. The product was immediately treated with water and extracted into diethyl ether or benzene and chromatographed on neutral alumina with benzene as the eluent. No signal was observed when B^{11} nuclear magnetic resonance spectra were attempted in highly concentrated solutions. Elementary analysis indicated a boron content of only 6.4 percent (theory for $B_{10}H_{10}(C_2)_2$ is 17.9 percent) and that the B-H stretching observed in the infrared at 4.1 microns was quite weak. Cleavage reactions of $B_{10}H_{10}^{-2}$ ions was investigated. The results of the most stable $B_{10}H_{10}^{-2}$ isomer with the hydroxide ion in water at 30.0° C are virtually complete. The overall rate expression is

$$-d(B_{10}H_{10}^{-2})\ 1dt = K_1[B_{10}] + K_2[B_{10}]\ [OH^-]$$

at constant ionic strength. Rate data were obtained under pseudo, first-order conditions. A series of rate runs were carried out at varying ionic strengths, and a strongly positive primary salt effect was observed. Application of this rate data to the Bronsted equation resulted in a slope which varied from 1.8 to 2.25 for the k_2 rate term. The k_1 rate was independent of ionic strength. I.v.L.

N63-13089 California U., La Jolla

ELECTRON PROBE MICROANALYSIS OF ORGANIZED ELEMENTS IN THE ORGUEIL METEORITE

Bartholomew Nagy, Kurt Fredriksson, George Claus, Christian A. Anderson, Harold C. Urey, and Joan Percy [1962] 19 p 21 refs Submitted for Publication
(NASA Grants NsG-98-60 and NsG-341; Contract AT(11-1)-34)
OTS: $1.60 ph, $0.80 mf

Electron probe X-ray microanalysis has shown that several of the organized elements contain major amounts of iron and, in addition, some chlorine and/or nickel. Morphologically less-well-developed microstructures are composed of hydrous iron-magnesium silicates. When powdered preparations of the Orgueil meteorite were boiled in 6N HCl for an hour, acid-resistant pellicles were obtained, which were found to be composed of carbonaceous matter. The presence of carbonaceous matter was deduced from measurements showing that the pellicles contained none of the elements detectable by the electron probe ($Z > 11$) and that their average atomic number agreed with that of the epoxy plastic in which they had been embedded for analysis. The finding of iron with some chlorine and nickel in organized elements in a petrographic thin section of the Orgueil meteorite shows that these particles are very probably not terrestrial contaminations. Electron microscopy of the HCl treated particles revealed organized structures, which suggests, but does not prove, biological origin. Author

N63-13092 Pratt and Whitney Aircraft, Middletown, Conn.

THE THERMAL DECOMPOSITION OF URANIUM MONOCARBIDE

P. A. Vozzella, A. D. Miller, and M. A. De Crescente Jan. 15, 1962 40 p 18 refs
(Contract AT(30-1)-2789)
(PWAC-378) OTS: $1.25

The thermal stability of uranium monocarbide was investigated using a modified Langmuir vapor pressure technique. The study led to the following observations:

1. Uranium monocarbide vaporizes congruently over the range 2010° C to 2230° C. At 2175° C the congruently vaporizing composition is $UC_{1.1}$.
2. The dominant mode of vaporization in the temperature range studied is

$$UC_{1.1} \rightarrow U(g) + 1.1\ C(g).$$

3. The vaporization rate in a high vacuum environment ranges from 2.0×10^{-4} g/cm²-sec at 2010° C to 38.3×10^{-4} g/cm²-sec at 2230° C.
4. The pressure of uranium over uranium monocarbide varies approximately linearly from 1.3×10^{-7} atm at 2010° C to 26×10^{-7} atm at 2230° C, while the carbon pressure varies from 0.3×10^{-7} to 6.4×10^{-7} over the same range.
5. The free energy change for vaporization in the range 2010° C to 2230° C may be expressed as

$$\Delta F = 306{,}000 - 65T\ (\pm 35\ \text{Kcal/gfw}).$$

6. The heat of vaporization of uranium monocarbide at 298K is 324.6 ± 2 Kcal/gfw.
7. The standard heat of formation of $UC_{1.1}$ at 298° K is −19.4 ± 2.0 Kcal/gfw. Author

N63-13119 Rock Island Arsenal Lab., Ill.
SYNTHESIS OF SILCARBANE POLYMERS USING CONVENTIONAL AND RADIATION INITIATION Technical Report
Ronald R. Freeman Dec. 14, 1962 17 p 17 refs
(RIA-62-4162)

Results are presented on the synthesis of silcarbane polymers from (1) diolefin silanes and silicon dihydrides initiated by platinum catalysts or gamma radiation, (2) divinyldimethylsilane using emulsion techniques with peroxide, metal and metal salts initiation, and (3) silicon dihydrides and 1,6 heptadiyne initiated by chloroplatinic acid. Silcarbane polymers prepared by the diolefin/dihydride reaction were low molecular weight (inherent viscosities ranged from 0.02 to 0.10) liquids to brittle solids. Benzene soluble powders, in low yields, were obtained in the emulsion polymerization of divinyldimethylsilane. Viscous liquids to rubbery polymers (inherent viscosities ranged from 0.05 to 0.40) resulted from the polymerization reactions of silicon dihydrides with 1,6 heptadiyne. The elastic gums were cured using conventional curatives or gamma radiation. Author

N63-13120 Rock Island Arsenal Lab., Ill.
POLYMERIZATION OF ALLYL MONOMERS BY MEANS OF GAMMA RADIATION Technical Report
W. Dennis Mc Henry Dec. 14, 1962 20 p 15 refs
(RIA-62-4163) OTS: $0.75

Poly (allyl alcohol), poly (allyl acetate), poly (allyl phenyl ether), and poly (allyl isothiocyanate) were produced from their monomers by the action of gamma radiation from Cobalt-60. Polymerization rates and solubilities of the polymers are given. Molecular weights were determined for poly (allyl acetate) and poly (allyl phenyl ether). Infrared spectra for poly (allyl alcohol) and poly (allyl phenyl ether) are presented. Author

N63-13131 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
APPLICATIONS OF LOCALIZED PERTURBATION TECHNIQUE
M. Asgar Ali (Keele U., Gt. Brit.) and Richard F. Wood Apr. 1, 1962 58 p refs
(Sponsored by Swed. Nat. Sci. Research Council and U.S. Air Force)
(Preprint 75)

Applications have been made of the localized perturbation technique for conjugated systems within the framework of Hückel theory by using the inverse of cyclic matrices in closed analytical form in terms of Chebyshev polynomials by the method of Löwdin, Pauncz, and de Heer. It is shown that, by this approach, one can get the exact energy levels and eigenfunctions of perturbed conjugated systems by a simple non-iterative method for simple perturbations and by a second-order iteration process for complicated perturbations which reduces the numerical "size" of the problem considerably. Possible applications of this technique in other related fields are discussed. Author

N63-13132 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
THE ENERGY BAND STRUCTURE OF POLYNUCLEOTIDES IN THE HUECKEL APPROXIMATION
J. Ladik (Hungarian Acad. of Sci.) and K. Appel May 15, 1962 13 p 7 refs
(Sponsored by Swed. Nat. Sci. Research Council and U.S. Air Force)
(Preprint 78)

Taking as model systems the polynucleotides poly A, poly T, poly G, poly C and poly U in a stereo arrangement according to the Watson-Crick model of DNA, the energy bands of these macromolecules were calculated in the Hückel approximation. Simple polynomial expressions were found for the energy values as functions of cos k, and with the aid of these the limits of all the occurring energy bands were determined. Some features of the obtained band structures are discussed. Author

N63-13133 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
INVESTIGATION OF THE π ELECTRON SYSTEM OF URACIL WITH DIFFERENT SEMIEMPIRICAL METHODS
J. Ladik (Hungarian Acad. of Sci.) and K. Appel June 1, 1962 15 p 11 refs
(Sponsored by Swed. Nat. Sci. Research Council and U.S. Air Force)
(Preprint 79)

The π-electron system of uracil was treated with the aid of the simple Hückel approximation, of the Hückel-CI method, of the semiempirical SCF-LCAO-MO method and with the SCF-LCAO-MO-CI method. The excitation energies and oscillator strength values of the first four excited states were calculated. The calculations were performed with two different approximations for the form of the inter-π-electronic repulsion integrals (γ). The first excitation energy obtained with the aid of the Hückel-CI method gives good agreement with the experimental value in the case of one series of γ integrals. The SCF calculation in general has given worse results than the Hückel method, taking into account the interaction of the π electrons and a limited CI (4 configurations) for the excited states. Since the interconfigurational matrix elements are very small, the CI has little influence on the results. The conclusion was drawn that neither of the mentioned semiempirical methods is suitable in its present form for the calculation of the spectra of heterocyclic molecules containing more than one heteroatom. The possibilities for the improvement of the methods are discussed. Author

N63-13136 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
INFRARED SPECTRA OF LIQUID AND SOLID CARBON MONOXIDE
George E. Ewing 8 p refs Repr. from J. Chem. Phys., v. 37, no. 10, Nov. 15, 1962 p 2250-2256
(NASA Contract NAS7-100)
(JPL-TR-32-357)

A low-temperature cell suitable for the study of the infrared spectra of pure liquids in the fundamental region is described. Selection rules are derived based on the assumption that diatomic molecules in the liquid state can undergo hindered rotation. The infrared absorption band shape is predicted to resemble the *P*- and *R*-branch envelope of the gas phase molecule in the wings, but to have an intense *Q* branch at the band center. The observed spectra of carbon monoxide as a liquid is in reasonable agreement with these selection rules. It is concluded that a considerable fraction of molecules in the liquid state can undergo nearly free rotation. The spectrum of carbon monoxide just below its freezing point suggests, however, that the rotatory motion of the molecules in the solid can best be described as librational. Author

N63-13156 Los Alamos Scientific Lab., N. Mex.
THE SOLUBILITY OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. I. CARBON
D. F. Bowersox and J. A. Leary Feb. 19, 1963 13 p 5 refs
(Contract W-7405-ENG-36)
(LAMS-2832) OTS: $0.50

The solubility of carbon in liquid plutonium has been measured over the temperature range 700° to 950° C. The solubility increases

from 690 ppm (by weight) C at 700° to 2350 ppm C at 950° C. The data fit the empirical equation

$$\log N_C = 0.50\text{-}2.30 \times 10^3\ T^{-1},$$

where N_C is the mole fraction of C and T is the temperature in degrees Kelvin. Author

N63-13171 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVESTIGATION OF THE EFFECTS OF GASEOUS DIFFUSION ON THE RATE OF OXIDATION OF A METAL FORMING A VOLATILE OXIDE

D. R. Schryer and J. L. Modisette Repr. from Phys. Chem. in Aerodynamics and Space Flight [1962] p 31-37

Data taken in flowing air and helium-oxygen mixtures have shown the oxidation rate of molybdenum to be dependent both on flow velocity and diffusivity in the temperature range 1945° to 2959° R. An extension of the Arrhenius equation to include flow and diffusion effects was found to correlate the data quite well for temperatures above 2400° R, at which the oxide formed was gaseous. The results obtained for molybdenum should be applicable to other metals forming volatile oxides in the appropriate temperature ranges. Author

N63-13189 National Aeronautics and Space Administration, Washington, D.C.

GAS CHROMATOGRAPHIC MEASUREMENT OF TRACE CONTAMINANTS IN A SIMULATED SPACE CABIN

Herbert C. McKee, John W. Rhoades, Ralph J. Wheeler, and H. P. Burchfield (Southwest Research Inst.) Mar. 1963 42 p 9 refs (Contract NASw-150)
(NASA TN D-1825) OTS: $1.25

Methods have been developed for sampling the air in a simulated space cabin and analyzing it for trace contaminants by gas chromatography. Compounds which were identified during five simulated flights include acetaldehyde, acetone, methanol, ethanol, Freon-11, Freon-12, Freon-22, methyl chloride, and dimethyl sulfide. The presence of Freon-114, isoprene, acetylene, ethylene oxide, carbon tetrachloride, methyl ethyl ketone, benzene, and toluene is also suspected, although identity has not been confirmed unequivocally. Several additional unidentified compounds were also present. A number of unidentified peaks appeared transiently during the malfunction of a waste disposal unit. Thus, gas chromatography has great potential value for monitoring the atmosphere within space capsules for metabolic products as well as for other contaminants introduced accidentially. Chemical tests were made for the presence of inorganic compounds in the atmosphere during two additional simulated flights. The presence of sulfate ion, chloride ion, chlorine, sulfur dioxide, ammonia, and ozone in trace amounts was confirmed. Author

N63-13214 Rice U., Houston, Tex.

EFFECTS OF NEUTRON AND ULTRAVIOLET IRRADIATION ON THE CATALYTIC ACTIVITY OF MAGNESIUM OXIDE

Jack H. Lunsford and Thomas W. Leland, Jr. Repr. from J. Phys. Chem., v. 66, 1962 p 2591-2597 24 refs
(NASA Grant NsG-6-59)

This work further develops a technique for changing the electronic and defect structure of magnesium oxide catalysts. Relatively small doses of ultraviolet and neutron irradiation have been found to enhance the catalytic activity of MgO for the reaction $H_2 + D_2 \rightleftarrows 2HD$. The enhancement by radiation depends on the extent of degassing of the catalyst prior to irradiation; the less active samples are more sensitive to irradiation. For samples activated at 291°, ultraviolet-irradiated MgO reaches a precise saturation value of catalytic activity, while neutron-irradiated samples continue to increase in activity upon further irradiation. Both types of irradiation produce a large initial increase in activity. Changes in activation energy depend on the thermal activation and type of irradiation. The activation energy either increases or remains unchanged for neutron irradiation, while ultraviolet irradiation does not cause a change. For this system, a simple model based upon Fe^{+3} as the irradiation-induced site has been developed. Other possibilities are discussed. It has been shown that most of the activity change must be attributed to changes in the electronic structure of the crystal rather than in the number of lattice imperfections. Author

N63-13226 Rensselaer Polytechnic Inst., Troy, N.Y.

ELECTROCHEMICAL BEHAVIOR OF A PALLADIUM HYDROGEN DIFFUSION ELECTRODE Scientific Report No. 2

L. Lederer and N. D. Greene Sept. 25, 1962 12 p 3 refs
(Contract AF 19(604)-8377)
(AFCRL-62-1051)

Electrochemical studies on palladium hydrogen diffusion electrodes indicate that sufficiently high current densities can be achieved to make their use as hydrogen electrodes in fuel cell applications practically feasible. Using a palladium oxide catalyst, formed by heating the electrode in air at 600° C, maximum current densities of 75 ma/cm² at a solution temperature of 24° C and 140 ma/cm² at 43.5° C were achieved. Author

N63-13238 Aeronautical Systems Div. Physics Lab., Wright-Patterson AFB, Ohio

QUANTITATIVE ANALYSIS OF ELASTOMERS THROUGH THE INFRARED SPECTRA OF THEIR PYROLYZATES

Freeman F. Bentley and George Rappaport (GM Corp. Inland Mfg. Div.) *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 49-67 27 refs (See N63-13234 07-01)

A semiquantitative method is described for determining polymer blends and copolymer ratios from the infrared spectra of their pyrolyzates (distillates). The method was established through the analysis of phenolic resin blends in Buna-N rubber, and by determining the percentage acrylonitrile in butadiene acrylonitrile copolymers. The method described here permits the semiquantitative analysis of Buna N phenolic resin blends, which, because of their physical state, cannot be analyzed by conventional methods. It also makes it possible to estimate the amount of noncombustible materials in these polymers. The method is based on the pyrolyzate technique combined with standard infrared quantitative procedures. Author

N63-13240 Dow Chemical Co., Midland, Mich.

THE PREPARATION AND PROPERTIES OF SOME NEW FLUORINE-CONTAINING 1, 2-EPOXIDES

Douglas A. Rausch and Alan M. Lovelace (ASD. Materials Central) *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 97-110 (See N63-13234 07-01)

The interest in fluorine-containing polyethers for possible application as thermally stable elastomers prompted research on the preparation of new epoxide monomers. Six new epoxides were prepared and characterized. The utilization of these monomers in new polymer systems is being investigated. Author

N63-13241 Monsanto Chemical Co. Research and Engineering Div., Everett, Mass.

DERIVATIVES OF FERROCENE. PART I. METALLATION OF FERROCENE

Marvin D. Rausch, Martin Vogel (Rutgers U.), and Harold Rosenberg (ASD. Nonmetallic Materials Lab.) *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 101-115 62 refs (See N63-13234 07-01)

The metalation of ferrocene by means of n-butyl-lithium and mercuric acetate has been further investigated. The lithiation reaction

has been extended for the preparation of trimethylsilylferrocene and 1,1'-di(trimethylsilyl)ferrocene. In the mercuration reaction, the ratio of starting materials has been varied in order to obtain optimum yields of either chloromercuriferrocene or 1,1'-dichloromercuriferrocene. Chloromercuriferrocene has been converted to diferrocenylmercury by means of dispersed sodium, sodium stannite, and sodium iodide in ethanol. Author

N63-13242 Monsanto Chemical Co. Research and Engineering Div., Everett, Mass.

DERIVATIVES OF FERROCENE. PART II. SOME REDUCTION PRODUCTS OF BENZOYLFERROCENE AND 1, 1-DIBENZOYLFERROCENE

Marvin D. Rausch, Martin Bogel (Rutgers U.), and Harold Rosenberg (ASD. Nonmetallic Materials Lab.) *In* Library of Congress. Science and Technology Div., Washington, D. C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 117-120 16 refs (See N63-13234 07-01)

The reduction of benzoyl- and 1,1'-dibenzoylferrocene to benzyl- and 1,1'dibenzylferrocene has been accomplished by either catalytic hydrogenation or by reduction with sodium and ethanol. 1-Hydroxybenzylferrocene has been prepared by the sodium borohydride reduction of benzoylferrocene, while the reduction of 1,1'-dibenzoylferrocene with lithium aluminum hydride has produced 1,1'-di(1-hydroxybenzyl)ferrocene. The action of a number of other reducing agents on these aryl ferrocenyl ketones is discussed. Author

N63-13243 Monsanto Chemical Co. Research and Engineering Div., Everett, Mass.

DERIVATIVES OF FERROCENE. PART III. THE PREPARATION OF SOME ACYLFERROCENES AND ALKYLFERROCENES

Marvin D. Rausch, Martin Vogel (Rutgers U.), and Harold Rosenberg (ASD. Nonmetallic Materials Lab.) *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 121-124 13 refs (See N63-13234 07-01)

Several new acylferrocones and 1,1'-diacylferrocenes have been prepared and reduced to the corresponding alkylferrocenes and 1,1'-dialkylferrocenes. Attempts to directly alkylate ferrocene resulted in mixtures of polyalkylated products. Author

N63-13244 Aeronautical Systems Div. Nonmetallic Materials Lab., Wright-Patterson AFB, Ohio

A ROOM TEMPERATURE VULCANIZATION SYSTEM FOR SELECTED FLUORINE-CONTAINING POLYMERS

Warren R. Griffin *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 125-135 14 refs (See N63-13234 07-01)

The development of a room-temperature vulcanization system for selected fluorine-containing polymers is described. A theory is postulated to explain the vulcanization involving attachment of reactive sites to the polymers at elevated temperatures followed by cross-linking through these sites at room temperatures. The formulation, characteristics, and test data are given for a hexafluoropropylene-vinylidene fluoride copolymer (Viton A*) vulcanized by this system. The technique appears applicable to the preparation of sealants, aerodynamic smoothers, and other related materials urgently required by the Air Force for advanced vehicles. Author

N63-13272 Armour Research Foundation, Chicago, Ill.

RESEARCH ON CHEMISTRY OF O_3F_2 AND O_2F_2 Technical Summary Report [No. 2], October 1-December 31, 1962

Irvine J. Solomon Feb. 13, 1963 11 p
(Contract AF 49(638)-1175) and ARPA Order 350-62)
(ARF 3227-2)

It has been established that O_2F_2 is unstable above -160° C. The analytical system for determining oxygen and fluorine has been checked with synthetic mixtures and has been shown to be satisfactory. Work on the characterization and chemistry of O_2BF_4 has continued. Electron paramagnetic resonance studies have shown that O_2BF_4 contains a free electron; approximately 12% of the molecules are paramagnetic. One mole of O_2BF_4 reacts with water to release all the oxygen in both the O_2BF_4 and the water. The oxygen is in the form of ozone and molecular oxygen. There seems to be a correlation between the method of sample preparation (temperature the sample is exposed to) and the amount of free radicals in the solid and the amount of ozone formed on hydrolysis. A new compound, tentatively assigned the formula O_2PF_6, has been obtained by the reaction of O_2F_2 and PF_5. Author

N63-13275 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

THE RELATIVE SIGNS OF THE NMR COUPLING CONSTANTS IN STYRENE OXIDE BY DOUBLE RESONANCE

Daniel D. Elleman and Stanley L. Manatt Repr. from J. Mol. Spectroscopy, v. 9, no. 4, Dec. 1962 p 477-486 21 refs
(NASA Contract NAS7-100)
(JPL-TR-32-310)

The relative signs of the nuclear magnetic-resonance spin-spin coupling constants between the three protons of the oxirane ring of styrene oxide have been determined to be the same by the audio-sideband-phase detection proton-proton decoupling technique. Author

N63-13297 France. Ministère de l'Air, Paris

ÉTUDE CHIMIQUE ET PHYSICOCHIMIQUE DES α-DICHLOROCYCLOHEXANONES [CHEMICAL AND PHYSICO-CHEMICAL STUDY OF THE α-DICHLOROCYCLOHEXANONES]

Dang Quoc-Quan Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Nov.] 1962 118 p 106 refs In French
(*Its* Publications Scientifiques et Techniques, N. T. 120) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

Chemical and physicochemical studies of α-dichlorocyclohexanones include: (1) preparation of the α-dichlorocyclohexanones; (2) chemical properties such as isomerization, dechlorohydration, and characteristic derivatives (dinitrophenylhydrazones, semicarbazones, oximes); (3) structural analysis by infrared and ultraviolet spectrometry and by dipolar moments; and (4) polarographic studies in the following media: aqueous, aqueous organic, and anhydrous organic. I.v.L.

N63-13307 Oak Ridge National Lab., Tenn.

OUTGASSING CHARACTERISTICS OF VARIOUS GRAPHITES

L. G. Overholser and J. P. Blakely Mar. 1, 1963 36 p 16 refs
(Contract W-7405-eng-26)
(ORNL-3396)

The outgassing characteristics of various graphites have been determined in vacuo to a maximum temperature of 1000° C using external resistance heating and to 1800° C by induction heating. The graphites examined include commercial and experimental lots of nuclear grades prepared from different sources of raw materials and subjected to varying manufacturing procedures. The ash content of the various grades ranges from ~ 5 to ~ 800 ppm, the calcium content from a few ppm to ~ 340 ppm. Representative data are presented which show marked differences in the composition of the desorbate and the fraction of the total evolved to various temperatures for different grades. The volume-time relationship is satisfactorily expressed as $v = A \log t + B$ for a number of the graphites over extended intervals of time. Marked deviations from this relationship at 600° C are reported for several grades of graphite characterized by a high calcium content. Variations in the CO_2/CO ratio in the desorbate at 600° C appear to be associated with these volume-time relationships observed at 600° C. Data are given which

show the differences in the degassing behavior of a group of graphites having ash contents of <30 ppm. These data fail to show any significant effect of either the type of coke or the particle size distribution of the coke used as filler. It appears that the atmosphere present during letdown and the subsequent exposure prior to degassing are responsible for the differences noted. The degassing behavior of samples of graphite from the stock for use in the Experimental Gas-Cooled Reactor is described, including the release of sulfur compounds as a function of temperature and volume-time relationships at various temperatures. Author

N63-13316 Wyandotte Chemicals Corp., Mich.
SYNTHESIS OF LOW TEMPERATURE OIL RESISTANT URETHANE ELASTOMERS Quarterly Progress Report No. 2, 1 October 1962 to 31 December 1962
S. L. Axelrood and W. J. Lajiness Jan. 1963 21 p
(Contract DA-20-018-ORD-24883)

Preparation and evaluation of urethane-urea elastomers were continued with emphasis on dichlorobenzidine (DCB) and toluene diisocyanate. The amine-to-hydroxyl ratio was varied on urethane-urea elastomer formulations based on two polyether triols, a 5200-molecular-weight polypropylene ether triol and a 7000-molecular-weight polyether triol containing a large percentage of ethylene oxide. The amine-to-hydroxyl ratio was varied from 1.5 to 2.5 in the series based on the former triol, from 1.5 to 10 on the latter triol. There was surprisingly little variation in torsional modulus at -55° C with variations in amine-to-hydroxyl ratio, even over the range from 1.5 to 10.0/1. However, as the amine-to-hydroxyl ratio increased from 1.5/1 to 10/1, the room-temperature torsional modulus increased from 260 to 3200. Introduction of ethylene oxide into the polyether chain decreases the oil absorption at the expense of increased water absorption. Author

N63-13318 Gt. Brit. Ministry of Aviation. Technical Information and Library Services, Mottingham
AUTOMATIC APPARATUS FOR ELEMENTARY ANALYSIS (AUTOMATICKE APARATURY PRO ELEMENTARNI ANALYSUE)
F. Vojtech Dec. 1962 7 p 13 refs Transl. from Chem. Prumsyl (Prague), v. 8, no. 33, 1958 p 633-636
(TIL/T-5107)

Three types of apparatus for estimating common elements in organic matter are described: (a) equipment based on the Dumas-Zimmerman principle, for nitrogen estimation; (b) equipment for Pregl and semi-microanalysis of carbon and hydrogen by rapid catalytic combustion; (c) a universal equipment for carbon, hydrogen, nitrogen, sulphur, and halogens on semi-microscale and microscale. Author

08 COMMUNICATIONS

Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

For tracking stations see: 10 Facilities.

For related information see: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

N63-13005 Naval Research Lab., Washington, D.C.
SYMMETRY PATTERN RECOGNITION SYSTEM II
F. R. Fluhr, D. J. Mc Laughlin, S. C. Wardrip, and R. J. Zack Jan. 10, 1963 70 p 3 refs
(NRL-5847)

Automatization of satellite detection in the SPASUR system requires a means of discriminating against a large population of nonsatellite responses. Early in the program, a study of SPASUR automatic gain control (agc) amplitude responses led to the development of a pattern recognition system based upon the inherent symmetry of a typical signal due to a satellite pass. This report describes the developed recognition system, called the Symmetry Recognition System II. The technical performance of the equipment placed in operation at the San Diego Space Surveillance Station (SPASURSTA) in November, 1961, is presented. During a ten-hour period on November 6, 106 alerts were generated, of which 20 were satellites which were correctly called symmetrical and 39 were nonsatellites which were rejected. Symmetry responses were generated on 14 alerts, some of which may have been due to remote, unverified satellite passes. No symmetry response was given to 33 verified satellites. Seven of these passes were missed due to agc pattern distortion by the SPASUR comb-filter switching action. Of the remaining signals, 25 were below the agc noise level and could not be examined for symmetry, and one low-level, short response was missed due to rapid signal fluctuations. It is concluded that recent design advances in the SPASUR system have minimized the requirement for pattern recognition processing. Author

N63-13023 Temco Electronics, Dallas, Tex.
4 KW VHF LINEAR AMPLIFIER (TYPE FA-5438) Final Report
Oct. 18, 1962 135 p
(Contract FAA/BRD-400)

The program aim was to develop and fabricate a long distance VHF communication ground linear amplifier. Two prototype amplifiers were completed. Each amplifier utilizes two ceramic ML 7007 beam power tubes in push-pull operating class AB_1 in a grounded cathode circuit. With the exception of these tubes, the entire amplifier is of solid-state construction. The amplifier was designated type FA-5438. Author

N63-13031 National Bureau of Standards, Boulder, Colo.
FADING CORRELATION BANDWIDTH AND SHORT-TERM FREQUENCY STABILITY MEASUREMENTS ON A HIGH-FREQUENCY TRANSAURORAL PATH
James L. Auterman Oct. 1962 58 p 15 refs
(NBS-TN-165) OTS: $0.40

Measurements of fading correlation bandwidth and of deviations of the instantaneous frequency from the average carrier frequency were made on the 4500-km auroral path from Barrow, Alaska, to Boulder, Colorado, at frequencies near 15 and 20 mc/s. The mean fading correlation bandwidth was found to be 4.3 kc/s. The value exceeded 90% of the time was 1.0 kc/s; the value exceeded 10% of the time was not obtainable. Generally, the bandwidth was smaller during periods of high magnetic activity or high fade rate. It also exhibited a minimum near midday. Cumulative distributions of instantaneous frequency deviations were obtained for a variety of conditions. The distributions generally agreed with a theoretical distribution based on a narrow-band Gaussian noise model if the proper normalizing factor was used. The factor was 1.4 times the measured fade rate. Distributions were also obtained of the percent of time the frequency deviations exceeded certain values for various time durations. Several examples of each type of distribution are presented. Author

N63-13043 Oklahoma State U. Research Foundation, Stillwater
A MINIATURIZED FIFTEEN-CHANNEL TELEMETRY TRANSMITTER FOR UPPER ATMOSPHERE RESEARCH
Oscar L. Cooper Repr. from Proc. Okla. Acad. Sci., v. 42, 1962 p 171-177
(NASA Contract NASr-4)

A miniature telemetry modulator has been designed for use in conjunction with a separate radio-frequency transmitting unit. The

combination may be used as a rocketborne fifteen-channel pulse-position transmitter in conjunction with existing ground receiving equipment. It has similar performance features to those of the AN/DKT-7, a larger and heavier airborne transmitter. It can be used to convert as many as 15 separate sources of voltage data into pulse-time information, which is then transmitted to the ground equipment for decoding. A.R.B.

N63-13072 Hughes Research Labs., Malibu, Calif.
A FEASIBILITY STUDY OF SATELLITE COMMUNICATION IN THE 15-20 Gc FREQUENCY RANGE Report No. 4
S. G. Lutz and S. C. Plotkin Jan. 1963 38 p 14 refs
(NASA Contract NASw-495)
OTS: $3.60 ph, $1.34 mf

An attempt is made to assess the feasibility and possible uses of satellite communication systems employing frequencies in the 15 Gc to 20 Gc range since both path loss and atmospheric absorption affect these systems at higher frequencies. Dry-climate, high-altitude sites are desirable for operation above 10 Gc and the beam elevations should be at least 10°. Some protection against the most severe but localized cloud and rain conditions is possible by means of geographic diversity, providing a choice exists between two or three stations separated from each other by 10 or more miles. It appears beyond present capabilities to increase the power output needed; thus, it is necessary to fall back on the limitation of the elevation angle to gain the required power. J.R.C.

N63-13097 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PRECISION ENDLESS-LOOP MAGNETIC TAPE RECORDER FOR SPACE APPLICATIONS
R. C. Falwell, K. W. Stark, and A. F. White Washington, NASA, Feb. 1963 20 p 3 refs
(NASA TN D-1542) OTS: 0.75

The tape recorder developed for the Tiros satellites is a miniaturized, low-power, two-speed recorder whose endless-loop tape cartridge stores 200 feet of ¼-inch lubricated magnetic tape. A two-phase 137.5-cps 14-vac hysteresis synchronous motor, requiring less than 0.300 watt, drives the tape at 0.4 inch/second for recording. During playback, a 500-rpm motor requiring less than 1 watt drives the tape at 12 inches/second. A transistorized d-c speed control unit maintains better than 1 percent regulation of this motor. Speed reduction from the motors to the capstan drive is obtained with reduction pulleys utilizing polyester film belts. Frictional drag from components not used during certain operating cycles is minimized by using spring clutches which prevent power drain on the motor. The record motor operates continuously, and spring clutches allow this motor to be overridden during the playback mode. Flutter and wow are maintained below 2.5 percent peak to peak from 0 to 1000 cps. This exceptional performance is made possible by an extremely accurate gyro-type capstan assembly. The capstan has maximum runouts of 5×10^{-5} inches and the assembly uses the duplex bearing and integral race technique. The bearings in this assembly are preloaded by means of a fixed center distance. This recorder has survived sinusoidal vibration at 10g from 0 to 2000 cps for ½ hour, and random vibration at 20g rms from 0 to 2000 cps for 4 minutes. A time-sharing switch, operated from the record mode reduction system, time-divides the information to be recorded. A playback timing switch, operated through a 16,650-to-1 gear reduction from the playback motor, activates a microswitch that cuts off power to the motor and resets the record mode electronics after a playback cycle of 3.33 minutes.
Author

N63-13154 Army Missile Command. Electromagnetic Lab., Redstone Arsenal, Ala.
POWER AND SIGNAL-TO-NOISE CALCULATIONS OF A CERTAIN PSEUDO-RANDOM SIGNAL
Eugene J. Mc Manus, Jr. Jan. 25, 1963 21 p
(RE-TR-63-1)

Calculations of power and spectral distribution for a particular pseudorandom waveform are presented. Signal-to-noise ratios are derived, and it is shown that the amplifier bandwidth which maximizes the output signal-to-noise ratio is given by $\frac{2}{\tau}$, when τ is the bit length in the pseudorandom sequence. Author

N63-13161 National Aeronautics and Space Administration, Washington, D.C.
RADIO TRACKING OF MARINER II AND ITS SCIENTIFIC IMPLICATIONS News Release No. 63-36-4
Feb. 26, 1963 6 p

Precise two-way Doppler tracking of Mariner II, during its 129-day flight to Venus and beyond, has provided data that has the potential to permit determining the mass of Venus with a probable error of 0.005 percent, according to NASA. Another significant result obtained was the exact location of the Goldstone tracking station, Deep Space Instrumentation Facility, within an accuracy of twenty yards. The way the station location is determined from the Doppler data may be understood by supposing the spacecraft to be fixed in space with respect to the center of the Earth. The only Doppler tone observed would be caused by the station's rotational velocity component along the direction to the spacecraft. The observed Doppler tone at the station depends, then, on the latitude, longitude, and radius from the center of the Earth. Since many measurements were obtained during many passes at the DSIF stations, it will be possible to deduce the proper combination of station location errors to match the data. The mass of the Moon may be determined by similar reasoning from the data. In this case, the variation in Doppler tone is due to the movement of the earth around the Earth-Moon system's center of mass, or barycenter. The Earth makes one revolution around this barycenter every 28 days at the speed of 27 miles an hour. I.v.L.

N63-13162 National Aeronautics and Space Administration, Washington, D.C.
MARINER II DEEP SPACE TELECOMMUNICATIONS News Release No. 63-36-5
Feb. 26, 1963 8 p

Communications between the Mariner II spacecraft and the Deep Space Instrumentation Facility (DSIF) stations on the earth in 1962 showed that reliable deep space communication to and from spacecraft is possible within the solar system, certainly to distances of 53 million miles, without disturbing effects from space itself, according to NASA. The DSIF includes stations at Goldstone, California; Woomera, Australia; and Johannesburg, South Africa. It was also demonstrated that extremely precise tracking is practical in deep space, particularly the radial velocity of the spacecraft from the earth, and that radial velocity of the order of one-tenth of an inch per second can be measured to distances of at least 53 million miles. The Venus radar experiments in 1962, from a station at Goldstone, California, reconfirmed: (1) the radar value of the astronomical unit (92,956,200 miles plus or minus 300 miles) as well as the prior reflection coefficient; and (2) the slow rotation rate of 230 plus or minus 40 to 50 days, retrograde (225 days retrograde is defined as nonrotating in Venus-based inertial coordinates). I.v.L.

N63-13164 Matrix Corp., Arlington, Va.
A FIELD SURVEY OF A SELF-TUTORING COURSE FOR ON-SITE TRAINING IN SAGE AN/FST-2 TROUBLESHOOTING
Edward C. Weiss Nov. 1962 28 p
(Contract AF 19(628)-1953)
(MATRIX Rept. 62-11; ESD-TDR-62-346)

A field survey was conducted to determine the present status of a self-tutoring course for on-site training in SAGE AN/FST-2 troubleshooting. The materials were originally issued to AN/FST-2 sites in the New York and Washington Air Defense Sectors in the spring of 1961. The purpose of this survey was to determine any problems which

might relate to the reissuing of the materials on a more extensive basis. In general, the materials were well received in the field. However, two classes of problems were revealed. One is administrative in nature, and the other is technical. These problems are fully discussed, and suggestions in the form of recommendations for their solution are offered. It was concluded that it would be feasible and desirable to reissue the materials. Author

N63-13187 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SELF-ERECTING FLEXIBLE FOAM STRUCTURES FOR SPACE ANTENNAS
Victor L. Vaughan, Jr., and Edward L. Hoffman Washington, NASA, Mar. 1963 17 p 1 ref
(NASA TN D-1610) OTS: $0.50

The concept of using flexible foam for the erecting mechanism and supporting structure of erectable Yagi disk antenna-elements for use in a space environment has been investigated. Tests were made to determine the recovery and stress-strain properties of the foams as they pertain to the erectable elements, and the effects of some vacuum and simulated solar radiation on these properties. Full-scale erectable Yagi disk antenna-elements were investigated for packaging and erection ability, vibration damping in a vacuum, and temperature differential in a vacuum. The electrical performance characteristics of the erectable elements were compared with those of a standard element. There were no significant detrimental effects of the simulated space environment on the recovery properties and resilience of the foam. The packaging, erection, damping, and temperature differential properties of the erectable elements were acceptable within the tolerances necessary for normal antenna performance. The electrical performance characteristics of the undisturbed erectable elements were essentially the same as those of a standard element. Author

N63-13254 Tokyo U. Inst. of Industrial Science (Japan)
THE ELECTRONICS OF THE KAPPA ROCKET
Noboru Takagi and Tamiya Nomura *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 75-96
(See N63-13251 07-04) OTS: $3.00

The telemetering and tracking equipment for the Kappa-8 sounding rocket is described, and future goals in system development are outlined. The telemetering system is a 225 Mc/s FM-FM 5-channel rocketborne transmitter with a ground based receiver-recorder system using a helical antenna. Tracking is done automatically with a parabolic antenna. The range finder system uses a split 15 Kc/s cycle and a standard crystal oscillator. Future plans call for a 10-channel telemetry system and a large tracking radar. R.C.M.

N63-13259 Tokyo U. Inst. of Industrial Science (Japan)
OPTICAL TRACKING OF ROCKETS
Takakazu Maruyasu and Tsuneyoshi Uemura *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 142-148 (See N63-13251 07-04) OTS: $3.00

The optical equipment used to track sounding rockets is described, and the role of optical tracking is discussed. The equipment consisted of two 35-mm Mitchell cameras with Canon 300-mm lens, a 35-mm Bell and Howell camera with 250-mm lens, a 16-mm Fastex high-speed camera, a 75-cm aerial camera, and a rocketborne camera. R.C.M.

N63-13296 Aro, Inc., Arnold Air Force Station, Tenn.
BIBLIOGRAPHY: RADIO TELEMETRY TO SURVIVE HIGH ACCELERATIONS
P. L. Clemens, comp. Arnold Engineering Development Center, Feb. 1963 28 p
(Contract AF 40(600)-1000)
(AEDC-TDR-63-36)

A bibliography is given that covers techniques which have been applied in the development of radio telemeters to survive high accelerations. Many entries also represent reporting of the results of tests imposed upon such telemeters. The items are listed in chronological order, by date of publication. Abstracts written by the author of each particular item are included where they were available. Because of the close dependence of successful high acceleration radio telemetry upon packaging techniques, references pertinent to the packaging problems have been added. Author

09 ELECTRONICS

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

For related information see: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.

N63-12842 Lincoln Lab., Mass. Inst. of Tech., Lexington
ON OPTIMAL CONTROL OF SELF-ADJOINT SYSTEMS
Michael Athanassiades, Peter L. Falb, and Richard T. Lacoss Oct. 15, 1962 31 p 18 refs Preprint
(Supported by U.S. Army, Navy, and AF)
(MS-709)

Given the system $\dot{x}(t) = A(t)x(t) + u(t)$, with $A(t) = -A'(t)$ and $\| u(t) \| \leq 1$, it will be shown that the control $u = -x(t)/\| x(t) \|$ drives any initial state to zero in such a manner that the response time, the consumed fuel, and a linear combination of time and control energy are minimized. The theory is applied to the optimum angular velocity control of a tumbling space body. Author

N63-12934 Illinois U. Coordinated Science Lab., Urbana
ON PHYSICAL REALIZABILITY OF SIGNAL FLOW GRAPHS AND REALIZATION TECHNIQUES
Manohar Lal Dec. 1962 54 p 26 refs
(Contract DA-36-039-SC-85122)
(R-157)

The problem of physical realizability of signal flow graphs was studied, and two classes of signal flow graphs were defined. It was shown that the class A encompasses all networks with independent sources, excluding mutual inductances. The second class, class B, was shown to cover a very large class of active networks. The realizability condition was given for both classes, and a realization technique was established for each class. An attempt was made to establish an algorithm for deriving a member of class A or class B signal flow graphs from the specified network function. Once the desired algorithm is set up, synthesis of networks will be possible in an alternate and relatively simpler way. J.R.C.

N63-12945 Radio Corp. of America. RCA Labs., Princeton, N. J.
EVAPORATED THIN FILM DEVICES Scientific Report No. 1, for the Period June 1, 1962 to November 30, 1962
P. K. Weimer, H. Borkan, V. E. Henrich, and F. V. Shallcross Nov. 30, 1962 44 p 15 refs
(Contract AF 19(628)-1617)
(AFCRL-62-965)

Additional evidence is presented to show that the dominant current control mechanism in the insulated-gate cadmium-sulfide thin-film transistor (TFT) is conductivity modulation in the semiconductor by field-effect action of the gate. Good agreement has been found

between the observed drain characteristics and those predicted by a field-effect analysis. The characteristics of the coplanar-electrode TFT having overlying "ohmic" contacts were demonstrated to be equivalent to the earlier staggered-electrode structure having underlying gold contacts. Experimental tests on cadmium-sulfide TFT structures incorporating Hall electrodes showed systematic differences between the measured Hall mobility and the measured drift mobility. The measured drift mobility as calculated from the ratio of transconductance to input capacitance may be either higher or lower than the measured Hall mobility, depending upon the method of preparation of the semiconductor film. An increase in the Hall mobility as a function of positive gate bias was found, contrary to predictions based upon the effect of scattering at the surface of a homogeneous semiconductor. To explain these two anomalies a nonhomogeneous film structure was postulated, consisting of relatively conducting crystallites of cadmium sulfide surrounded by insulating barriers. Measurements on input capacitance, switching speeds, and the temperature dependence of drain characteristics and Hall mobilities were made. Tests on various processing procedures and electrode contacts were carried out for cadmium sulfide and other materials potentially useful for TFT fabrication. Author

N63-12954 Rome Air Development Center. Applied Research Lab., Griffiss AFB, N. Y.

A NONUNIFORMLY DISTRIBUTED PARAMETER MATCHING NETWORK FOR THE MICROWAVE FREQUENCIES

Daniel J. Kenneally (M. S. Thesis–Syracuse U.) Jan. 1963 37 p 27 refs

(RADC-TDR-63-17)

A nonuniform section of coaxial transmission line is investigated as an impedance matching network. Assuming that the purity of the dominant transverse electromagnetic (TEM) mode is maintained, the coaxial transformer section proposed is one in which the distributed series inductance and shunt capacitance are prescribed mathematical functions of the axial cylindrical coordinate, that is, the direction of propagation. These variations are expressed as a variable characteristic impedance in the explicit form of a half-period cosinusoidal distribution. The network itself is realized by machine tapering the inner conductor of a coaxial line in the mathematically prescribed manner within ±0.5 mil accuracy. The experimental unit is designed to corroborate the predicted performance for an arbitrarily chosen mismatch of 0.50 voltage (unmatched) reflection coefficient. A measurement procedure is presented and the results discussed in terms of experimental measurement accuracies, approximate theory, and overall compatibility between theory and experiment. Author

N63-12957 Army Missile Command. Guidance and Control Lab., Redstone Arsenal, Ala.

THEORETICAL ANALYSIS OF A TYPICAL SAMPLED-DATA SYSTEM

H.R.McCarley Jan.21, 1963 15p

(TRG-TR-63-5)

Closed-loop servomechanisms are usually linear feedback systems operating on continuous signals. There is, however, a distinct class of servomechanisms which operates on "sampled data." In these systems the input, or actuating signal, is represented by samples at regular intervals of time with the information carried in the amplitude by the samples. The analysis of "sampled data systems" presents several features quite different from those found in continuous systems. The error is measured, the correction applied, and then the system passes through a waiting period before the next error measurement. This results in a tendency to over-correct for the accumulated error. The report presents a mathematical stability analysis of a typical sample data servo using the Z transform and root locus. The system was simulated on a Donner 3200 analog computer, and the results from this simulation were used to verify the calculated results. Author

N63-12970 Watkins-Johnson Co., Palo Alto, Calif.

Technical Progress Report No. 14, 1 November 1962 through 31 January 1963 [DEVELOPMENT OF A GRIDDED 100 KW L-BAND AMPLIFIER FOR APPLICATION IN PHASED-ARRAY RADAR SYSTEMS]

James W. Sedin Feb. 8, 1963 18 p

(Contract AF 19(628)-500)

A gridded 100-kw L-band amplifier suitable for application in phased-array radar systems is developed. The grounded cathode tube design utilizing a ceramic barrel appears to be reasonably satisfactory from an electrical point of view. The gridded gun operates satisfactorily at low duty cycles. Problems associated with grid expansion could develop at full-duty cycle but they do not seem to be serious ones. Grid cutoff characteristics are such that it would be possible to reduce the grid current to about 10 percent of the cathode current without increasing the total-grid voltage swing to more than 500 volts. The capacitively coupled rf windows are completely satisfactory at low-duty cycle and no serious problem is anticipated at full-duty cycle. The efficiency and gain of the tube are difficult to obtain because of the poor focusing under rf drive. J.R.C.

N63-12986 Doucette (E.I.) Associates, Inc., Chatham, N.J.

A QUANTITATIVE STUDY OF THE EVOLUTION OF GASES FROM ELECTRON TUBES AND MATERIALS Third Scientific Report; Period Covered, June 18, 1962 to September 18, 1962

W. H. Grubbs, G. H. Snider, and F. I. Scott Oct. 31, 1962 36 p

(Contract AF 19(628)-326)

(AFCRL-62-923)

This program aims to achieve a higher degree of reliability in electron tubes through a better and more comprehensive understanding of the kinds and quantities of gases which occur in these tubes. A bakeable, ultraclean, high vacuum system which incorporates an omegatron mass spectrometer has been constructed for conducting these investigations. Essentially all of the effort during this report period has been devoted to the construction and calibration of the various orifice systems utilized in the equipment. The results obtained indicate that the objectives of the study can in fact be achieved, and work is currently progressing in this direction. Some preliminary degassing experiments are described. Author

N63-13074 Little (Arthur D.) Inc., Cambridge, Mass.

EXPERIMENTS WITH ACORN III

Martin L. Cohen Feb. 8, 1963 23 p

(Working Memo. ACORN-24)

A pilot model of a two-dimensional acornetwork (Acorn III) was built to test the electrical behavior of this type of network (used for associative information retrieval). A tree pattern was used containing 119 subject nodes and 62 document nodes. The network was coupled with 390 resistors (2200 ohm 10% tolerance). The input conductance was determined for each node along with the ratio of impedance between grounding and coupling elements. The accuracy of Acorn III was determined by measuring the variation of the output voltage of synonymous subject nodals. The maximum variation in voltage of synonymous subjects was slightly more than 1%. R.C.M.

N63-13101 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A MAGNETIC CORE VOLTAGE-TO-FREQUENCY CONVERTER

Stephen Paull Washington, NASA, Feb. 1963 17 p 2 refs

(NASA TN D-1677) OTS: $0.50

In a pulse frequency modulation (PFM) telemetering system, there is a need for a subcarrier oscillator with these characteristics: (1) operating frequency a linear function of a d.c. input control voltage, (2) high input impedance, (3) square wave output with constant amplitude over the entire frequency range, and (4) frequency stability within one cycle during gated on-off operation. This paper describes a method for controlling the frequency of a square-loop

magnetic core oscillator by means of a d.c. voltage to give a voltage-to-frequency converter with the above characteristics. Various design considerations are discussed; and a voltage controlled oscillator that operates from 15 to 5 kc as the input control voltage varies from 0 to +5 volts is used as the design example. Author

N63-13147 Rome Air Development Center. Applied Research Lab., Griffiss AFB, N. Y.

THE APPLICATION OF TUNNEL DIODES TO A REFLECTING ANTENNA ARRAY

James R. Forgione, Edward J. Calucci, and Charles M. Blank Jan. 1963 25 p 25 refs
(RADC-TDR-63-4)

The feasibility of microwave frequencies of enhancing the reflectivity from a two-element array of broadband coaxial dipoles, each terminated by tunnel diode reflection amplifiers without the use of stabilization networks, has been demonstrated. Theoretical analysis of a reflection amplifier is presented along with experimental results of the two-element array at "S" band. Author

N63-13150 Parke Mathematical Labs., Inc., Carlisle, Mass.

ELECTRON STRAGGLING—THEORY AND CALCULATION Scientific Report No. 10

Nathan Grier Parke III Aug. 1962 21 p
(Contract AF 19(604)-7316)
(AFCRL-62-973)

Some conceptual difficulties in the theory of straggling are discussed and Landau's 1934 result is compared with that obtained by the method of random energy walk over successive impacts. Landau's differential equation is rederived and basic assumptions stated. Author

N63-13153 Syracuse U. Research Inst., N.Y.

PROBABILISTIC NETWORK STUDY—SYSTEM RELIABILITY Final Report

F. M. Reza Aug. 1962 47 p 30 refs
(Contract AF 19(604)-6169)
(S.U.R.I. Rept. EE747-6208FR; AFCRL-62-724)

A formal proof is given for a well-known statement of Shannon. Shannon states that for very large T, the number of distinct permissible messages of length T behaves as $A_i\ r_i^T$, where r_i is the largest positive root of the characteristic equation. It is proved here that the characteristic equation cannot possess complex conjugate roots leading to a dominant term. A new sampling theorem is presented using Berstein's orthogonal polynomials as the basis. Some similarity between the problem of approximation with $B_n(t)$ and the fundamental theorem of information theory is denoted. A new relation between positive real functions of Circuit Theory and the h(p) functions of Reliability Theory is given. A mathematical transformation is described for associating a realizable impedance function to a realizable reliability function. This idea provides a new source of constraints for realizable reliability functions. Author

N63-13157 Watkins-Johnson Co., Palo Alto, Calif.

WIDE BAND ELECTRONICALLY TUNABLE FILTERS Technical Note No. 1, Covering the Period 1 July to 30 September 1962

K. L. Kotzebue and A. W. Shaw Oct. 1962 33 p
(Contract AF 30(602)-2625)
(W-J 62-609R5; RADC-TDR-62-607)

Work on hysteresis, linearity, and temperature compensation in YIG filters is discussed, and measurements are reported for hysteresis using both core iron and hypernik pole piece in a WJ-501 filter (2-4 Gc reciprocal bandpass filter). Hysteresis amounts to about 0.1 percent of the tuning range for hypernik pole pieces. Linearity and temperature compensation measurements are reported for core iron pole pieces. Linearity is ± 2 mc and resetability ± 3 mc. With the filter adjusted for minimum temperature coefficient at 3 Gc, the temperature coefficient at 4 Gc was maximum of 0.1 mc° C. A four-stage X-band bandpass filter and a two-stage X-band band-reject filter are described. The X-band bandpass filter suffers from band distortion above 11 Gc as also does the band-reject filter. Even below 11 Gc some improvement of the X-band bandpass filter will be necessary to meet the objectives of the program. The X-band band-reject filter gave the required 50-db rejection at single frequencies, but the two resonators gave tracking difficulty. Initial studies of strip-line circuits for use below 8 Gc are also outlined. Author

N63-13159 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

OPTIMIZATION OF MULTIVARIABLE SAMPLED-DATA CONTROL SYSTEMS

Jean Lieutaud Sept. 1962 55 p 6 refs
(Grant AF-AFOSR-62-295)
(PIBMRI-1078-62)

This study is concerned with the optimization of multivariable sampled-data control systems. A squared error performance criterion is chosen, and the effects of controllability and observability are studied. In particular, it is shown that the optimization can always be carried out on a system all of whose coordinates are both controllable and observable. In each case several illustrative examples are included. Author

N63-13202 McMurry Coll., Abilene, Tex.

FOURTH PROGRESS REPORT

Virgil E. Bottom, Gerald Montgomery, Bill Le Bus, and Tommy Cook Feb. 1963 22 p
(Supported by Collins Radio Co., Newport Beach, Calif.)

The values of L, C, and C_o have been determined empirically for circular AT-cut plates in the frequency range, 3 to 5.5 mc. The data are presented in graphical form for use in the design of quartz resonators for use as components in filter networks. The data may also be useful in the design of units for oscillator applications. The data cover all practical values of contour and electrode size on plates having a fixed diameter of 0.550 inches. Author

N63-13232 Shockley Transistor Corp., Palo Alto, Calif.

A FEASIBILITY STUDY OF A NEW FOUR LAYER DIODE AS A PULSE MODULATOR SWITCH [Final] Technical Documentary Report

Kurt Hubner and R. M. Scarlett Griffis AFB, N.Y., Techniques Lab., Oct. 3, 1962 47 p
(Contract AF 30(602)-2811)
(RADC-TDR-62-497)

A feasibility study is given of a new four-layer diode especially suited as a pulse modulator switch. The two main features of the new type four-layer diode are: first, a voltage-current characteristic which, at low currents prior to switching, is like that of an avalanche diode; and second, a collector junction configuration which has a higher breakdown voltage at the periphery (which is exposed to the ambient) than in the center region. The first feature drastically reduces the complexity of pulse modulator circuitry by permitting series operation of the devices without dividing networks, the second ensures a high degree of reliability. The aim of this work was to demonstrate feasibility of series operation of a large number of these units and to show that the maximum current ratings of the devices can be increased by enlarging the active silicon device area. Author

N63-13258 Tokyo U. Inst. of Industrial Science (Japan)

LOW NOISE AMPLIFIER FOR RADAR

Shigefumi Saito and Joji Hamazaki *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 133-141 2 refs (See N63-13251 07-04) OTS: $3.00

A low noise parametric amplifier has been developed for use with the rocket-tracking radar system. The input frequency was designed to equal the 1680 MC transmission frequency of the rocket-borne transponder. Unidirectional tubes are used to stabilize the klystron pump power source which operates at a frequency of 7800 Mc. The half value for the gain at 22db is 10 Mc, and the overall noise number is approximately 2db. With this low noise level, the signal range of the transponder can be increased by a factor of four. R.C.M.

10 FACILITIES

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

For related information see: 06 Auxiliary Systems.

N63-12936 Atomic Energy Commission. Div. of Reactor Development, Washington, D. C.

NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1962

[1962] 25 p

This compilation covers facilities in the United States that are capable of sustaining a nuclear chain reaction. Civilian, military, and production reactors, as well as reactors for export and critical assembly facilities, are covered. R.C.M.

N63-12973 Atomic Energy Commission, Bombay (India)

5.5 MILLION VOLT DAN DE GRAAF ACCELERATOR AT TROMBAY

A. S. Divatia, T. G. Varghese, Joseph John, M. R. Dwarakanath, T. P. David, M. S. Bhatia, K. B. Nambiar, P. R. Dhoot, K. K. Sekharan, N. S. Thampl, P. R. Sundar Rao, and J. C. Maliakal 1962 34 p 11 refs

A Van de Graaff accelerator and auxiliary facilities recently installed at the Atomic Energy Establishment in Trombay, India is discussed and results of test and calibration experiments performed are summarized. Highlighted topics were: the high voltage generator, the accelerating system, the beam analyzing system and the energy stabilizing system. A.R.B.

N63-13098 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN, OPERATION, AND TESTING CAPABILITIES OF THE LANGLEY 11-INCH CERAMIC-HEATED TUNNEL

Otto F. Trout, Jr. Washington, NASA, Feb. 1963 33 p 23 refs (NASA TN D-1598) OTS: $1.00

General design problems are reviewed for ceramic heat exchangers operating at temperatures up to 4,500° R for heating air for supersonic free jets and wind tunnels. Supersonic water-cooled nozzles and premixed-gas combustion equipment have been designed for this type of facility. A description of the Langley 11-inch Mach 6 ceramic-heated tunnel and the Langley 4-inch Mach 4 ceramic-heated airjet utilizing a 4,500° R zirconia heat exchanger is presented. Author

N63-13182 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

LOW-POWER TEST OF THE PLUM BROOK REACTOR

Harold W. Giesler, Harry J. Reilly, and William A. Poley Washington, NASA, Feb. 1963 50 p 11 refs (NASA TN D-1560) OTS: $1.25

The initial criticality and subsequent low-power tests of the NASA Plum Brook Reactor core are described. Results of control-rod calibrations, flux mapping, and other measurements are given. The minimum critical size core was found to consist of 11 elements in a $3 \times 3 + 2$ lattice containing about 1.78 kilograms of uranium 235. The cold clean 3×9 core with 168-gram elements had an excess reactivity of 12.0 percent. The maximum differential reactivity worth of the bank of five fueled shim-control rods was measured to be about 2 percent reactivity per inch, and the total worth of each automatically controlled regulating rod was not more than 0.6 percent reactivity. The reactor temperature coefficient was an average of –0.0075 percent reactivity per °F over the range 70° to 170°F. The void coefficient was –0.25 percent reactivity for each percent moderator void, for up to 8 percent total moderator void. Thermal neutron flux traverses of the core indicated the highest fluxes to be in elements LB-6, LC-6, and LD-6, and that the flux peaking increased about 50 percent as the rods were inserted halfway into the core. The relative distributions and the magnitudes of the fluxes were also determined, both in the core and outside the core. Gamma heating measurements were made, and some of the results are shown. Author

N63-13281 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

NONUNIFORM BURNUP AND POISONING EFFECTS IN A REACTOR AND VALIDITY OF UNIFORM APPROXIMATION

Robert B. Spooner Washington, NACA, Mar. 9, 1953 18 p 6 refs (NACA RM E53D20) OTS: $0.50

The nuclear-reactor simulator at the NACA Lewis Laboratory has been applied to an investigation of the validity of the customary assumption of uniform distributions of fuel burnup and fission-product poisoning in a reactor core. The two-group calculation results show the effects of this approximation for a specific power reactor in which the initial power density varied by a factor of approximately 4 over the core volume. For this reactor, the nonuniform fuel burnup and poisoning were satisfactorily approximated by equivalent uniform distributions of burnup and poisoning in the reactor core for the conditions of 10-percent fuel burnup or less and for equilibrium xenon-135 concentrations. Only slight distortions of 4 percent or less in power density resulted from the approximations. However, for operation at the maximum xenon-135 concentration condition approximately 10 hours 50 minutes after shutdown, the approximate power density solutions diverged from the more detailed results by as much as 24 percent at the reactor center. Author

11 FLUID MECHANICS

Includes: boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow, 03 Aerodynamics of Wings and Control Surfaces; 13 Heat Transfer; and 24 Physics, Plasma.

N63-12930 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THEORETICAL INVESTIGATION OF UNSTEADY DIFFUSION WITH RECOMBINATION IN A TERNARY MIXTURE OF DIATOMIC MOLECULES, DISSOCIATED ATOMS, AND AN INERT GAS

Walter A. Reinhardt Washington, NASA, Feb. 1963 35 p 6 refs (NASA TN D-1651) OTS: $1.00

An experiment is suggested wherein measurements can be made on parameters leading to the determination of the homogeneous reaction and diffusion rates of oxygen atoms. This is done by studying the decay in the periodic time variation in concentration of atoms. The system to be investigated includes a ternary gas mixture of diatomic molecules, dissociated atoms, and an inert gas. A theoretical investigation is made, starting with equations obtained from rigorous kinetic theory and chemical kinetics, of the unsteady diffusion and recombination processes applicable to the experiment. Boundary conditions are investigated. A qualitative result is given which illustrates the dependence of the decay in the concentration variation on sink strength and frequency. Author

N63-12987 Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.

EXPERIMENTAL INVESTIGATION OF THE STRUCTURE OF VORTICES IN SIMPLE CYLINDRICAL VORTEX CHAMBERS

Coleman duP. Donaldson and Richard S. Snedeker Dec. 1962 61 p 10 refs

(Contract AF 49(638)-255)

(ARAP-47)

An experimental study of the character of vortices in simple cylindrical vortex chambers completely open at one end is presented. Special attention is given to the problem of the transition from one-celled to two-celled vortex structure. It is shown that for turbulent vortices in vortex chambers having length-to-diameter ratios in the range $0 < L/D < 5$, the character of the flow is primarily dependent on the ratio of a characteristic tangential velocity to a characteristic radial velocity V/U. In addition, it is shown that the Reynolds number based on the radial flow, while a parameter of major importance in laminar vortices, plays but a minor role in turbulent vortex motion. Transition from one-celled to two-celled vortex structure started for all vortex configurations tested ($0 < L/D < 5$) when V/U exceeded approximately 3. Author

N63-13001 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.

NONEQUILIBRIUM CENTERED EXPANSION OF A DISSOCIATED SUPERSONIC GAS FLOW

R. J. Shanahan and G. R. Inger (Aerospace Corp.) Oct. 26, 1962 62 p 15 refs

(SM-42492)

An analysis is presented of the nearly frozen, nonequilibrium supersonic expansion of a dissociated diatomic gas around a sharp, two-dimensional corner, assuming an incoming stream in dissociation equilibrium. The analysis is based on a small perturbation technique in which small local departures from frozen flow near the corner are treated. The analysis is necessarily restricted in lateral extent but covers the entire angular range of the flow field and, therefore, brings out the nonlinear aspects of the nonequilibrium behavior. An exact analysis is presented (in similitude form for a diatomic gas) in which numerical procedures are required to effect the solution. However, in the exact solution, the expression for the atomic species mass fraction has been placed in closed form and, in conjunction with appropriate approximations, is used to determine the thermochemical field in an additional solution (applicable to hypersonic flow) which is approximate but entirely in closed form. Some numerical results for the first-order nonequilibrium flow field are presented in which the main physical features of the nonequilibrium effects are shown, the influence of various thermochemical parameters are determined, and the accuracy of the approximate solutions is assessed. Author

N63-13019 General Applied Science Labs., Inc., Westbury, N.Y.

AXIAL VARIATIONS OF ELECTRON DENSITY IN THE LAMINAR WAKE OF A NOL TEST SPHERE

A. Fields Jan. 31, 1963 7 p 6 refs

(GASL-TM-76)

Results of wake calculations are presented for the test conditions under which spheres will be fired in the 1000 ft. Naval Ordnance Laboratory range. The sphere diameter is 1.25 inches; the flight velocity 1600 fps., and the freestream temperature 520° R. Two freestream pressure levels were chosen, namely 10 mm and 50 mm Hg. I.v.L.

N63-13036 Aro, Inc., Arnold Air Force Station, Tenn.

THE SHOCK SHAPE AND SHOCK DETACHMENT DISTANCE FOR SPHERES AND FLAT-FACED BODIES IN LOW-DENSITY, HYPERVELOCITY, ARGON FLOW

A. B. Bailey and W. H. Sims Arnold Engineering Development Center, Feb. 1963 66 p 32 refs

(Contract AF 40(600)-1000)

(AEDC-TDR-63-21)

An experimental investigation has been made to determine the pressure distribution, shock shape, and shock detachment distance for spheres and the latter two characteristics for flat-faced bodies in a heated argon flow where $M_\infty = 4$ to 14, $T_0 = 1900°$ to 4100° K, and $Re_2 = 25$ to 225. The modified Newtonian approximation for the pressure distribution, which is strictly an empirical relationship, gives good results when applied to the first 60 deg of a hemisphere under conditions where the body boundary layer and the shock layer merge. The natural flow visualization produces as a result of the high total temperature and consequent excitation of the argon enabled this study to be made. Photographs taken of the shocks generated by a series of spheres and flat-faced bodies were analyzed with a photodensitometer to determine the shock shape and shock detachment distance. The blast analogy predicts a difference in the shape of shocks in argon and air at high Mach numbers and Reynolds numbers. An empirical relationship proposed by Love was used to calculate the shock shape in air for Mach numbers corresponding to those of the present investigation. When this shape was compared to the shape measured in argon at the same Mach number, it was found that the difference in shape was in agreement with that predicted by the blast analogy, i.e., for a constant value of x/D then $(y/D_{argon}/(y/D)_{air} = 1.16$. Also, it appears even for the lowest Reynolds number tested that nondimensionalized shock shape is independent of Reynolds number for spheres and flat-faced bodies when the effect of Reynolds number on detachment distance is taken into account. A study of the shock detachment distance indicates that the boundary and shock layers were either incipiently or fully merged in these experiments. Furthermore, for the Reynolds number range of the present tests, the detachment distance is a function of wall temperature, Reynolds number, Mach number, and body shape. As the Reynolds number decreases, the shock detachment distance increases to values more than double the "inviscid" values. Also, for the water-cooled bodies, there is evidence to confirm the decrease in detachment distance to less than the inviscid value, as predicted by Ho and Probstein, before the increase as mentioned previously for the lowest Reynolds numbers. Author

N63-13061 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

EXPERIMENTAL STUDY OF CYLINDER AND SPHERE WAKES AT A MACH NUMBER OF 3.7

J. M. Kendall, Jr. Nov. 13, 1962 22 p 15 refs

(NASA Contract NAS7-100)

(JPL-TR-32-363) OTS: $2.60 ph, $0.86 mf

Measurements of circular cylinder and sphere wakes have been made at a Mach number of 3.7 by the use of a pitot tube, a temperature probe, and hot-wire anemometers. Descriptions are given of the development of unsteadiness and turbulence in the wake. Fluctuation waveforms are shown, and periodic vortex shedding is described. The behavior of the mean flow is shown to depend on the wake fluctuations. Author

N63-13080 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ON THE FLOW OF A CONDUCTING FLUID OF SMALL VISCOSITY
Stephen Childress Jan. 31, 1963 23 p 15 refs
(NASA Contract NAS7-100)
(JPL-TR-32-351) OTS: $2.60 ph, $0.89 mf

Two-dimensional and axially symmetric flows of an incompressible fluid of finite conductivity are studied in the inviscid limit. With the assumption that the magnetic field and velocity are parallel at infinity, it is pointed out that, in general, there exists no stationary solution of the magnetohydrodynamic equations which represents flow past an obstacle and which, at the same time, is well behaved at infinity. It is suggested that the classical continuous inviscid limits are, in the magnetohydrodynamic problem, related to a class of flows which are regular in an exterior region everywhere, except possibly at the point at infinity where finite perturbations in the velocity persist. Assuming that there exist solutions having the required properties, flows past finite obstacles are characterized by the behavior of the classical Bernoulli function. The appearance of finite perturbations at infinity in the limit of vanishing viscosity is further illustrated by consideration of magnetohydrodynamic flow into a sink or out of a source. If the magnetic field is strong, and in the case of sink flow, a well-behaved inviscid limit is found. The corresponding source flow is regular at infinity only if the viscosity of the fluid is finite. Author

N63-13085 Naval Ordnance Lab. Explosions Research Dept., White Oak, Md.
UNDERWATER EXPLOSION PHENOMENA: THE PARAMETERS OF MIGRATING BUBBLES
Hans G. Snay Oct. 12, 1962 29 p 10 refs
(NAVORD-4185)

The migration of underwater explosion bubbles caused by gravity (buoyancy) affects the energy of the pulsation as well as period and maximum radius in the second and subsequent cycles. Experimental data on periods of explosions in various depths are analyzed, and the bubble energy is determined for five cycles of the oscillation as a function of the strength of migration. The result is given in dimensionless form which permits the calculation of periods, maximum radii, and migration for a wide range of conditions. An energy balance shows the surprising result that the bubble energy of the second cycle increases with increasing intensity of migration until a maximum is reached at a condition of strong migration. Beyond this point, the energy decreases again. This gain is found to be due to the decrease of the energy radiated by the bubble pulse. Author

N63-13087 California Inst. of Tech. Hydrodynamics Lab., Pasadena
AN EXPERIMENTAL INVESTIGATION OF A FULLY CAVITATING TWO-DIMENSIONAL FLAT PLATE HYDROFOIL NEAR A FREE SURFACE
Thomas Emmett Dawson (Thesis–1959) and E. R. Bate, Jr. Oct. 1962 72 p 18 refs
(Contract N123(60530)31686A)
(E-118.12)

An experimental program was conducted to investigate the characteristics of a fully cavitating two-dimensional flat-plate hydrofoil in the presence of a free surface. The submergence of the hydrofoil was varied from the planing condition at the free surface to a depth corresponding to 2.16 model chords. Near the surface, the cavities are formed by venting to the atmosphere, but at the deeper submergences, they had to be artificially formed by supplying them with air. The normal force, the moment about the leading edge, the center of pressure location, the cavity length, and the volumetric airflow rate into the cavity are presented as functions of angle of attack, cavitation number, Froude number, and proximity to the free surface. Author

N63-13110 Notre Dame U., Ind.
ON THE CALCULATION OF UNSTEADY INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS OVER ARBITRARY CYLINDERS
Kwang-Tzu Yang Nov. 1962 70 p 32 refs
(Contract Nonr-1623(11))
(Tech. Note 62-11)

This report deals with the calculation of unsteady laminar boundary layers over arbitrary cylinders in an incompressible flow. The calculation procedure is based on an improved integral solution to the governing unsteady boundary-layer equations. The essential feature of this improved solution is to treat the usual integral solution as a first approximation, which is then used to linearize the governing equation in such a way that improved unsteady velocity profiles in the boundary layer are readily obtained. Author

N63-13116 General Applied Science Labs., Inc., Westbury, N.Y.
A FINITE-DIFFERENCE METHOD SOLUTION OF THE LAMINAR HYPERSONIC, NON-EQUILIBRIUM WAKE
Seymour L. Zeiberg and Gary D. Bleich Feb. 15, 1963 58 p 29 refs
(GASL-TR-338)

A finite-difference method is used to solve the system of equations governing the hypersonic laminar wake with nonequilibrium air chemistry. Numerical results are compared with integral method results (both having the same initial conditions, and the same chemistry model). The results show some significant differences between the two methods; these differences could materially alter the radar and thermal radiation characteristics computed for the wake. Author

N63-13137 Technical Research Group, Syosset, N.Y.
UNSTEADY LIFT, MOMENT, AND CAVITY LENGTH CALCULATIONS FOR AN OSCILLATING PARTIALLY CAVITATED HYDROFOIL
Herbert Steinberg Sept. 1962 61 p 3 refs
(Contract Nonr-3434(00))
(TRG-153-SR-2)

This report contains the results of calculations of the unsteady force, moment, and cavity length of a partially cavitated hydrofoil subject to unit heave or pitch oscillations. These can be combined with arbitrary amplitude and phase. Included also are analytic descriptions of the zero-cavity-length limit and of the zero-frequency limit. Numerical results for these limiting cases are also included. Author

N63-13160 Canadian Armament Research and Development Establishment, Valcartier
ON THE DEVELOPMENT OF A METHOD FOR PREDICTING THE GASEOUS RADIATION CHARACTERISTICS OF BLUNT BODIES AT HYPERSONIC SPEEDS. PART 2—IBM 1620 DIGITAL COMPUTER PROGRAM FOR FLOW FIELD SOLUTION IN SHOCK CAP
D. Ellington and D. A. Keeley Feb. 1963 120 p 3 refs
(ARPA Order 113)
(CARDE-TM-726/63)

A digital computer program written in FORTRAN is presented, which may be used to obtain solutions for the chemical and thermodynamic state of the inviscid flow field regime in the shock cap of a hypersonic blunt body, including the effects of finite chemical relaxation times. The program was written for the IBM 1620 machine and is based on a gas model comprising an interacting mixture of Lighthill ideal dissociating gases. The shock-cap flow solution is based on Freeman's direct method, extended to include a mixture of three dissociating species. Author

N63-13196 National Aeronautics and Space Administration. Goddard Space Studies, New York, N.Y.
STABILITY OF A ROTATING LIQUID COLUMN
J. Gillis and K. S. Suh Repr. from Phys. Fluids, v. 5, no. 10, Oct. 1962 p 1149-1155 5 refs

The stability of a rotating cylindrical column of liquid with a concentric solid core is discussed. The critical value of the surface tension is determined for the case of a viscous liquid, and, for a nonviscous liquid, the problem is solved for axisymmetric and plane perturbations. The physical significance of the results is also discussed. Author

N63-13284 Minnesota U. Rosemount Aeronautical Labs., Minneapolis

HYPERSONIC FLOW PROBLEMS DURING RE-ENTRY INTO THE ATMOSPHERE

Rudolf Hermann 1962 24 refs Repr. from 1961 WGL Yearbook Presented at the Annual Meeting of the Wissenshaftliche Gesellschaft fur Luftfahrt, Freiburg, Oct. 1961 p 131-144
(NASA Grant NsG-83-60; NSF Grant NSF-GI1581)

The atmosphere is the environment in which reentry occurs, hence it must be known in its undisturbed condition. A simplified density distribution is assumed. The general equations of motion, valid for a body during reentry, are discussed. For the hypersonic flow around the body, the thermodynamic state of the gas at the stagnation point is of great importance. Stagnation enthalpy as function of flight velocity is derived, and stagnation pressure and temperature are presented as functions of both flight velocity and altitude. A large amount of stagnation enthalpy is absorbed in dissociation. A simplified model of the air, with only oxygen and nitrogen in dissociation, is used to calculate the degree of oxygen and nitrogen dissociation as function of temperature and pressure in general. Then it is discussed as function of velocity and altitude during reentry. Basic bodies for the study of flow in hypersonic aerodynamics are flat plate, hemisphere, and blunt cone. Interaction between boundary layer and shock wave, producing an induced pressure on the flat plate, is of significance at high Mach numbers and low Reynolds numbers. Theory and wind-tunnel experiments are compared. In contrast, the pressure distribution and velocity gradient near the stagnation point of a sphere are little affected by viscosity and are well approximated by Newtonian theory. Finally, the dissociation of oxygen in flow around a sphere is calculated for a particular free-flight condition. The oxygen dissociation distribution and the resulting temperature distribution on the surface of a sphere, assuming thermodynamic equilibrium, are discussed as calculated for typical hypersonic high-temperature wind-tunnel conditions. Author

12 GEOPHYSICS

Includes: auroral phenomena; upper atmospheric studies; cartography; geodesy; and geomagnetism.

For Van Allen belts see: 28 Space Radiation.

For related information see: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

N63-12905 Texas U. Electrical Engineering Research Lab., Austin

FURTHER STUDIES OF THE DIRECTIONAL PROPERTIES OF MAGNETOTELLURIC SIGNALS

L. D. Provazek, H. W. Smith, and F. X. Bostick, Jr. Washington, Office of Naval Research, Feb. 20, 1961 56 p 14 refs
(Contract Nonr-375(01))
(Rept. 119)

Preliminary measurements of the directional properties and phase relations of the magnetotelluric fields at Austin, Texas, were described previously. In this report, these measurements have been extended to include a large number of cases over the period from April 13 to October 26, 1960. In addition, the measurement of the direction of the vertical components and the total variable magnetic field have been included. Author

N63-12958 Minnesota U. Cosmic Ray Group, Minneapolis

THE FLUX OF HEAVY NUCLEI IN THE JULY 10, 1959, FLARE

S. Biswas (NASA, Goddard Space Flight Center) July 1962 4 p 5 refs Repr. from J. Geophys. Research, v. 67, no. 7, July 1962 p 2613-2615
(Contract Nonr-710(19))
(CR-49)

During 59-70 hours after the July 10, 1959, flare, the differential energy spectra of M nuclei ($6 \leq Z \leq 9$) and H nuclei ($Z \geq 10$) were measured in the energy intervals 150-500 and 200-500 mev/nucleon, respectively. Also the integral flux of H nuclei of energy >500 mev/nucelon was measured. It is concluded that during this period the solar M-nuclei flux was $\lesssim 0.9 \pm 0.3$ percent of solar α-particle flux in the energy interval 150-200 Mev/nucleon; and the solar H-nuclei flux of energy 200-300 mev/nucleon was zero or undetectable. Author

N63-12959 Alaska U. Geophysical Inst., College

THE DEVELOPMENT OF THE MAIN PHASE OF MAGNETIC STORMS

S. -I. Akasofu and S. Chapman Repr. from J. Geophys. Research, v. 68, no. 1, Jan. 1, 1963 p 125-129 12 refs
(NASA Grant NsG-201-62)

The development of the main phase and of auroral activities during magnetic storms is examined for a number of storms. It varies much more than a mere difference of pressure of the solar streams would seem to produce. Some intrinsic differences between solar streams are suggested. Author

N63-13014 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

LABORATORY SPECTRA OF THE ULTRAVIOLET OXYGEN AIRGLOW

Charles A. Barth and Morris Patapoff Repr. from Astrophy. J. v. 136, no. 3, Nov. 1962 p 1144-1147 12 refs
(NASA Contract NAS7-100)
(JPL-TR-32-300)

The excitation mechanisms of the night-airglow of the Herzberg bands of molecular oxygen and the 5577 A atomic oxygen line are investigated in a simulated airglow. Emphasis was placed on trying to determine whether the Herzberg bands are the result of a three-body recombination of oxygen atoms coming from an excited molecule in the $A^3\Sigma$ state or whether atomic oxygen was excited in the ^1S state, the upper state of the 5577 A line in a single three-body collision. In the laboratory work conducted, the 2972 A atomic oxygen line (radiated from the same upper level, the ^1S, as the 5577 A line) was observed simultaneously with the Herzberg bands in the afterglow source (0.4% oxygen atoms and 95.5% molecular nitrogen), in which oxygen atoms were the sole energetic species. The conclusion drawn, based on this observation and in agreement with an explanation of Barth (1961), indicated that the 5577 A line is excited in a two-step process. A metastable oxygen molecule is first formed in a three-body recombination. It then transfers its energy to an oxygen atom in a single three-body collision. B.J.C.

N63-13032 Chicago U., Ill.

THEORY OF AURORAL BOMBARDMENT SUPPLEMENTARY REMARKS

Joseph W. Chamberlain (Yerkes Observatory) Repr. from Astrophys. J., v. 136, no. 2, 1962 p 678-679 2 refs
(NASA Grant NsG-118-61)

A revision of the author's previous paper, *Theory of Auroral Bombardment, (1961)*, is presented. In particular, the bombardment process postulated is reformulated to include the conservation of the magnetic moment μ of the trapped particles, including particles drifting toward a region of excess charge. Since, in this modified picture, it is the low energy plasma that is accelerated into the aurora by the energetic trapped particles, these regions of low density may maintain themselves and remain relatively stable. They would then be capable of producing recurrent ray structure, undergoing the motions described in the previous paper. M.P.G.

N63-13049 Ohio State U. Research Foundation, Columbus

ELECTRON IMPACT STUDY OF NITROGEN

Edwin N. Lassettre and Frederic M. Glaser Dec. 1962 32 p 18 refs (Contract AF 19(604)-4541)
(Sci. Rept. 6; AFCRL 63-212)

The present study is a reinvestigation of the electron-impact spectrum of nitrogen. Electron-impact spectra of nitrogen are reported at accelerating voltages of 150, 200, 300, and 400 volts. Since the resolution of the spectrometer is greater than in previous studies, more detailed structure is observed in the spectra, and several of the peaks are correlated with bands observed in the vacuum ultraviolet absorption spectrum. A simple method of determining oscillator strengths is used to obtain the oscillator strengths for three prominent peaks. The results are compared with the previous determination. Author

N63-13091 Michigan U. High Altitude Engineering Lab., Ann Arbor

ANALYTIC SOLUTION FOR ATMOSPHERIC DENSITY FROM SATELLITE MEASUREMENTS OF STELLAR REFRACTION Technical Report

P. B. Hays and F. F. Fischbach Jan. 1963 7 p 3 refs
(NASA Contract NASw-140; ORA Proj. 04963)
OTS: $1.10 ph, $0.80 mf

The demonstration of an analytic solution for index of refraction (i.e., density) as a function of height is of fundamental importance to the satellite refraction technique. First, it proves the existence of a unique inverse function. Second, it allows a simpler, much quicker evaluation of the function, virtually assuring that the data reduction can be completed in real time. Third, it allows immediate programing of the data reduction process and, in turn, a sophisticated error analysis, including simulation of satellite data and density-function retrievals. Fourth, it focuses attention on equipment requirements; which become the only major area in which feasibility has not been established. Variation of parameters in the simulated data will assist in specifying the instruments. Author

N63-13115 California U., Berkeley

SIMULTANEOUS ELECTRON PRECIPITATION IN THE NORTHERN AND SOUTHERN AURORAL ZONES

R. R. Brown, K. A. Anderson, C. D. Anger, and D. S. Evans Feb. 7, 1963 20 p 3 refs Submitted for Publication
(Supported by NSF, Air Force, and Navy)
(AFOSR-420)

During simultaneous high-altitude balloon flights from College, Alaska, and Macquarie Island, Australia, on March 5, 1962, substantial fluxes of auroral zone X-rays were observed in both hemispheres during magnetic bay activity. The X-ray observations indicate that the electron influx in both hemispheres extended over a region 3° wide in latitude and 16° in longitude. The near equality of the X-ray fluxes in both auroral zones suggests that the electron precipitation originated from processes far out on the lines of force, near the equatorial plane. The magnetic and ionospheric disturbances accompanying the X-ray event are discussed. Author

N63-13173 National Aeronautics and Space Administration, Washington, D.C.

GEOPHYSICS AND ASTRONOMY News Release, February 11, 1963

John E. Naugle 1963 34 p [Presented at] 2nd NASA-Industry Program Plans Conf., Departmental Auditorium, Washington, D.C. February 11-12, 1963

The Geophysics and Astronomy Program of the National Aeronautics and Space Administration is discussed in terms of objectives, funding, and flight schedules. The Geophysics and Astronomy Program is concerned with scientific and technological studies that can be achieved with spacecraft in the vicinity of the earth. The disciplines represented by the program include astronomy, solar physics, space chemistry, and geophysics. The Orbiting Astronomical and Solar Observatories are the spacecraft associated with the first two disciplines, and the Geophysical Observatory supports both chemistry and physics. Outside of launch vehicles, the OAO and the OGO are the major items in the budget, requiring 64 percent of the $174.2 million budget. The major problem in the program continues to be reliability. A need exists for more reliable tape recorders or devices for storing information onboard the spacecraft. The data collected in this program are of practical importance to the Manned Space Flight Program for computing rendezvous orbits and determining the extent of the radiation hazard. Other areas of application include the data necessary to predict the behavior of a communications satellite in a 24-hour orbit. R.C.M.

N63-13176 Committee on Extension to the Standard Atmosphere (COESA)

U. S. STANDARD ATMOSPHERE, 1962. ICAO STANDARD ATMOSPHERE TO 20 KILOMETERS. PROPOSED ICAO EXTENSION TO 32 KILOMETERS. TABLES AND DATA TO 700 KILOMETERS

Washington, GPO, Dec. 1962 281 p 48 refs
(Sponsored by NASA, AF, and Weather Bureau)

The "U.S. Standard Atmosphere, 1962" is a product of COESA generated under the impetus of increased knowledge of the higher atmosphere and more accurate determinations of basic quantities, such as redefinition of the absolute thermodynamic temperature scale. For all practical purposes the "U.S. Standard Atmosphere, 1962" is in agreement with the International Civil Aviation Organization (ICAO) Standard over their common altitude range. Background information, including a brief historical statement, is given in the Foreword. Part I gives the basis for the main tables of atmospheric properties and contains a full development of gravity and geopotential as well as the basic assumptions, formulas, and derived quantities. In Part II additional information relating to the atmosphere is given, including discussion of systematic variations, observed and inferred extremes, and representations of atmospheric variables as approximate analytic functions of altitude. Part III contains the main tables of atmospheric properties to 700 kilometers calculated in both metric and English units. Author

N63-13255 Tokyo U. Inst. of Industrial Science (Japan)

INVESTIGATION OF THE UPPER ATMOSPHERE BY ROCKET SOUNDING

Ken'ichi Maeda *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 97-109 10 refs (See N63-13251 07-04) OTS: $3.00

Upper atmospheric studies by sounding rocket are reviewed, and plans for future research are outlined. The observations made include ion density of the ionosphere, temperature distribution, wind direction, wind velocity, cosmic rays, solar radiation, and sound propagation. Future plans call for studies of the composition of the atmosphere, physical nature of the exosphere and ionosphere, field intensity and structure, and the electromagnetic spectra. R.C.M.

N63-13264 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE EXCITATION OF ELECTROACOUSTIC WAVES BY ANTENNAS IN THE IONOSPHERE

H. A. Whale Repr. from J. Geophys. Res., v. 68, no. 2, Jan. 15, 1963 p 415-422 12 refs

Measurements of the impedance at 7.75 Mc/s of an electrically short antenna in the ionosphere indicate that power is absorbed by some mechanism other than electromagnetic radiation. The importance of the radiation of energy as an electron pressure (electroacoustic) wave generated near the antenna is discussed, and it is shown that the calculated power radiated by this mechanism yields in good agreement with the observations. Author

N63-13285 Aberdeen Proving Ground. Ballistic Research Labs., Md.

ROCKET AND SATELLITE IONOSPHERE STUDIES USING A DIGITAL RAY TRACING PROCEDURE: SUMMARY REPORT

George A. Dulk and William A. Dean Dec. 1962 146 p 38 refs (Partially supported by DASA)

(BRL-1163)

The development of data acquisition, data handling, and data analysis techniques for the study of the ionosphere and ionospheric effects on radio signals is summarized. The instrumentation system and ionospheric effects on radio signals is summarized. The instrumentation system and equipment and the handling of the Faraday rotation and dispersive Doppler data are given. Also, the ray tracing program which is currently being used to analyze rocket and satellite radio signals is described. Some of the advantages of the ray tracing technique are the provision for a time-varying, three-dimensional ionosphere model and use of the complex Appleton-Hartree equation to compute such quantities as Faraday rotation, Doppler, dispersive Doppler, and absorption. A sample of preliminary results is given and discussed. Author

N63-13286 Johns Hopkins U., Baltimore, Md.

RESEARCH IN ATMOSPHERIC MECHANICS Final Report

George S. Benton et al Dec. 1962 82 p 31 refs

(Contract AF 19(604)-6147)

(AFCRL-63-209)

Extracts of papers published as a result of research in atmospheric mechanics are presented. The topics include: (1) quantitative relationships between atmospheric vapor flux and precipitation; (2) large-scale atmospheric spectra at 200 Mb; (3) barotropic stability of the mean winds in the atmosphere; (4) studies of the structure of the Ekman layer in shear flow; and (5) a quasi-Lagrangian system of coordinates for steady-state flow of a perfect fluid. M.P.G.

N63-13304 Pennsylvania State U. Ionosphere Research Lab., University Park

PERTURBATION METHODS APPLIED TO THE REFLECTION OF RADIO WAVES FROM THE IONOSPHERE

P. W. Norman Feb. 1, 1963 32 p 10 refs

(Contract AF 19(604)-4563)

(Scientific Rept. 178; AFCRL-63-215)

A perturbation approach to the problem of determining the electromagnetic field reflected from the ionosphere is presented. It is shown that by treating the earth's field of magnetic induction as a perturbation, Maxwell's equations and the constitutive relationship are considerably simplified. First-order approximations for the field reflected from a homogeneous sharply bounded ionosphere are found. The perturbation method to be developed has certain limitations which are discussed. Author

13 HEAT TRANSFER

Includes: ablation; cooling; heating; and other thermal effects.

For aerothermodynamics see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings and Control Surfaces.

For combustion see: 26 Propellants and Combustion.

For related information see: 11 Fluid Mechanics.

N63-12891 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SHOCK-LAYER RADIATION OF BLUNT BODIES TRAVELING AT LUNAR RETURN ENTRY VELOCITIES

William A. Page N.Y., Inst. of the Aerospace Sciences, [1963] 20 p 11 refs Presented at the IAS 31st Annual Meeting, New York, Jan. 21-23, 1963

(IAS Paper-63-41) IAS: $0.50 members, $1.00 nonmembers

Measurements were made of total thermal radiation from the shock layer about small gun-launched models flying either in still air or upstream through the test section of a shock-tube-driven hypersonic wind tunnel. Total velocities ranged up to 41,000 ft/sec. Current knowledge of shock-layer radiation is evaluated by comparing the results with available predictions of equilibrium radiation and with shock-tube measurements of nonequilibrium radiation. Scaling rules and methods for predicting radiative heating of full-scale vehicles are discussed. Author

N63-12898 Avco-Everett Research Lab., Everett, Mass.

NON-EQUILIBRIUM AND EQUILIBRIUM RADIATION AT SUPER-SATELLITE RE-ENTRY VELOCITIES

R. A. Allen, P. H. Rose, and J. C. Camm N. Y., Inst. of the Aerospace Sciences, [1963] 36 p 49 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963

(IAS Paper-63-77) IAS: $0.50 members, $1.00 nonmembers

An electric arc-driven shock tube has been developed which produces shock waves at supersatellite reentry velocities. Photometric measurements of the radiation behind normal air shock waves have been made in this high performance shock tube, and the engineering estimates of the radiation heating derived from these measurements are described. Measurements were made of the nonequilibrium and equilibrium radiation from normal air shocks at initial pressures varying from 1.0 to 0.05 mm Hg (simulated altitudes 110,000 to 255,000 ft.) and at shock velocities from 16,500 to 36,200 ft./sec. A calibrated grating, dual channel, monochromator, and photomultipliers were used to obtain photometric measurements between 0.22 and 0.9 microns wavelength. A tungsten photoelectric gage was used to obtain quantitative intensity results in the 0.075- to 0.14-micron region, and a single channel prism monochromator with an infrared cell was used to obtain coverage at wavelengths beyond 1.0 micron. From time histories of the resolved shock front radiation at various wavelengths and at various velocities and pressures, a parametric description of the radiation was obtained. Spectroscopic techniques using an image converter and a drum camera operating in the racetrack mode were used to obtain time-resolved spectra. $N_2^+(1-)$ and atomic nitrogen line radiation are found to be significant contributors to both the equilibrium and nonequilibrium radiation at 33,000 ft./sec. Experiments performed at different conditions of pressure and shock velocity validated "binary scaling" of nonequilibrium radiation. "Collision limiting" of the $N_2^+(1-)$ band system radiation was also observed. A summary of existing data on nonequilibrium air radiation was made. The value of $\frac{40 \text{ watts}}{\text{cm}^2 - 2\pi \text{ ster.}}$ at 33,000 ft./sec determined from the present experiments was in good agreement with both the Ames Research Center ballistic range results covering the

same velocity range and empirical extrapolations of our previous measurements in the vicinity of 23,000 ft./sec. Currently, it is not possible to accurately predict nonequilibrium radiation from a given normal shock wave at high velocities. The present state of the theoretical knowledge of nonequilibrium radiation and methods of folding experimental results into flow calculations are summarized. Finally, the engineering implications of the radiation results presented are explored. Author

N63-12919 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge

APOLLO GUIDANCE AND NAVIGATION. THE HEAT TRANSFER PROPERTIES OF STRUCTURAL ELEMENTS FOR SPACE INSTRUMENTS

Richard M. Jansson June 1962 22 p 5 refs
(NASA Contract NAS9-153)
(E-1173) OTS: $2.60 ph, $0.86 mf

Heat transfer by conduction through contacting metals in a vacuum was investigated in hope of applying principles gained to design criterion for components that will be subjected to the space environment. Aluminum and beryllium test specimens of various machine finishes were investigated under a range of contact pressures, and with the insertion of several different filler materials between the contacting surfaces. Similar tests were performed on bearing assembly configurations. The tests on aluminum and beryllium provided no specific information relating any given surface finish to thermal resistance; only ranges of values were obtained for a given material and load. Conduction was shown to be the primary interface heat transfer mechanism. It was determined that varying surface roughness should yield different thermal resistances when a fluid is present at the interface, however in the absence of fluid, the conduction is dependent upon the contact points alone. The use of a filler material yielded a significant reduction of interface resistance. A.R.B.

N63-12972 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

CASCADE INVESTIGATION OF COOLING CHARACTERISTICS OF A CORRUGATED-INSERT AIR-COOLED TURBINE BLADE FOR USE IN A TURBOPROP ENGINE

Hadley T. Richards Washington, NASA, Mar. 1960 15 p 3 refs
(NASA TM X-85) OTS: $1.60 ph, $0.80 mf (Declassified)

The cooling effectiveness of a small air-cooled turbine blade for use in a turboprop engine was experimentally investigated in a static cascade facility. Three test blades of 1.4-inch span and 0.7-inch chord were subjected to combustion-gas temperatures of about 1060°, 1360°, and 1660° R. The blade cooling-air temperatures ranged from about 560° to 800° R. Gas Reynolds numbers varied from 85,000 to 380,000. The cooling effectiveness of the corrugated-insert blade reported herein was found to be almost identical with that of a cast-finned blade investigated previously. At the root region, the corrugated-insert blade was from 18° to 65° F cooler than the cast-finned blade. This range of temperature corresponded to about a 10-percent improvement in the cooling effectiveness of the blade. A nondimensional method of correlating the experimental heat-transfer data of the blades, which had been developed for a preceding blade design (previously report), was utilized successfully with the data of this investigation. Author

N63-13011 Naval Air Development Center. Aviation Medical Acceleration Lab., Johnsville, Pa.

FLAME CONTACT STUDIES. II. EXPERIMENTAL VALIDATION OF MATHEMATICAL ANALYSIS OF HEAT FLOW

Alice M. Stoll Dec. 26, 1962 19 p 5 refs
(NADC-MA-6216)

Mathematical equations for transient heat flow through a two-layer wall are examined, corrected, and validated experimentally for application to thin layers of material (0 to 1 mm thick) during short-term heating (3 sec) in gas flames. Author

N63-13013 Naval Air Development Center. Aviation Medical Acceleration Lab., Johnsville, Pa.

FLAME CONTACT STUDIES. III. DETERMINATION OF THERMAL PROPERTIES OF MATERIALS IN THIN LAYERS

Alice M. Stoll Dec. 26, 1962 16 p 7 refs
(Rept.-30; NADC-MA-6217)

A method is described whereby thermal diffusivity and conductivity may be determined in thin layers of material. It is demonstrated by application in a study of fabrics ranging in thickness from 0.12 to 0.29 mm. The system is adaptable to use in similar measurements in living skin. Author

N63-13027 Atomic International, Canoga Park, Calif.

CRITICAL HEAT FLUX OF SOME POLYPHENYL COOLANTS

H. Lurie and J. M. Robinson (AiResearch Mfg. Co., Los Angeles) Feb. 1, 1963 30 p 19 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7954) OTS: $0.75

The critical heat flux (CHF) of Santowax R (a polyphenyl mixture), of Santowax R containing diphenyl and/or radiolytic high boilers, and of coolant from the Organic Moderated Reactor Experiment (OMRE) was measured as a function of mass velocity, subcooling, and pressure under forced convection, subcooled boiling conditions. The data were correlated by equations of the form $q_c = A + B\Delta T_s G^{0.8}$ where q_c = critical heat flux, Btu/hr-ft^2; ΔT_s = subcooling, °F, and G = mass velocity, lb/sec-ft^2. A and B are empirical constants that depend only on the coolant composition. Over the range of variables covered, the critical heat flux data were correlated by:

a) Santowax R $q_c = 198{,}000 + 14.5\Delta T_s G^{0.8}$
b) A mixture of Santowax R and 27 wt % radiolytic high boilers (HB) $q_c = 353{,}000 + 16.9\Delta T_s G^{0.8}$
c) Mixture (b) with diphenyl added to give 2.9 to 7.4 total wt % diphenyl $q_c = 282{,}000 + 23.0\Delta T_s G^{0.8}$
d) OMRE, Core II coolant $q_c = 219{,}000 + 29.2\Delta T_s G^{0.8}$

At the same subcooling and mass velocity, the critical heat flux increases as a result of adding radiolytic high boilers to Santowax R. For $\Delta T_s G^{0.8} \geq 11{,}000$, the CHF of Santowax R + HB + diphenyl is greater than the CHF of Santowax R + HB, and that of OMRE coolant is higher than either. Author

N63-13246 Aeronautical Systems Div. Nonmetallic Materials Lab., Wright-Patterson AFB, Ohio

THE EFFECT OF GRAVITY ON FREE CONVECTION HEAT TRANSFER. THE FEASIBILITY OF USING AN ELECTROMAGNETIC BODY FORCE

David A. Kirk *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 155-187 39 refs (See N63-13234 07-01)

Theories concerning the instability and motion of a fluid heated from below predict the effect of various physical parameters. Experimental investigations have succeeded in widely varying all parameters, except gravity, in order to determine the validity of the theories. In extraterrestrial heat transfer applications, such as in free convection, boiling, and condensation, the effect of gravity should be verified by experiment. This report considers the feasibility of using an impressed electromagnetic body force acting parallel to the earth's gravitational field. The resultant of this electromagnetic force and the ground level gravitational force is said to be an "equivalent gravitational" force acting on the fluid mass. Based on the analysis made, a series of experiments can be performed to ascertain the quantitative contribution of gravity, over the range from −13.6 to 15.6 times ground level gravity, on free convection heat transfer. An apparatus is presently being fabricated to conduct an experiment for the case when heat is applied from below. Author

N63-13248 Ames Lab., Iowa State U. of Science and Tech.

HIGH CONDUCTIVITY FINS FOR GAS COOLED LIQUID-METAL HEAT EXCHANGERS

William F. Brown, Ray W. Fisher, and Henry M. Black Jan. 1963 32 p 10 refs

(Contract W-7405-eng-82)

(IS-587) OTS: $0.75

Copper fins are nickel-plated and brazed to the Inconel tubes of an air-cooled liquid-sodium heat exchanger for use up to 600° C. Methods of plating annular fins for tubes are discussed, and test results are presented. Brazing techniques for fin-to-tube joints are explored, and a resistance brazing process is developed and explained. From the results of the tests, it was concluded that resistance brazing is an acceptable process and that electroplating is successful on fins only under very limited conditions. Author

14 HUMAN BEHAVIOR

Includes: crew training and evaluation; piloting; psychological factors.

For simulators see: 10 Facilities.

For related information see: 16 Life Sciences.

N63-12884 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VISUAL CAPABILITY OF PILOTS AS APPLIED TO RENDEZVOUS OPERATIONS

J. E. Pennington and R. F. Brissenden N.Y., Inst. of the Aerospace Sciences, [1963] 12 p 18 refs Presented at the IAS 31st Annual Meeting, New York, Jan. 21-23, 1963

(IAS Paper-63-15) IAS: $0.50 members, $1.00 nonmembers

Visual capability of pilots as applied to rendezvous operations was investigated. The following phases of rendezvous were studied: (1) acquisition, (2) establishment of intercept, (3) range and range rate estimation, (4) braking operations, and (5) docking. The corresponding visual tasks, given in the same sequential order, were: (1) detection, (2) angular rate discrimination, (3) angular rate discrimination, (4) distance and closure rate judgment, and (5) attitude. The corresponding target parameters, given in the same sequential order, were: (1) intensity color-signal sequence, (2) motion cues, (3) motion cues, (4) size, shape, and motion cues, and (5) aspect. Results indicated that, for the conditions considered, man can perform the rendezvous efficiently. However, the optimum use of both man and machine is necessary for maximum efficiency and reliability. In providing this integration, it should be kept in mind that man, if not overloaded, can be the most reliable and versatile element in the system. Optical and electronic aids can considerably reduce the workload of the pilot, making it easier for him to exercise his prime responsibility, i.e., judgment and control. Consequently, devices that do not subordinate the pilot to the equipment are strongly recommended. I.v.L.

N63-12885 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CREW PERFORMANCE AND PERSONAL OBSERVATIONS ON A LUNAR MISSION SIMULATION

Donald L. Mallick and Harold E. Ream N.Y., Inst. of the Aerospace Sciences [1963] 12 p Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963

(IAS Paper-63-18) IAS: $0.50 members, $1.00 nonmembers

To study the performance of a crew in prolonged space flight, a simulation of a lunar-landing mission was made. Three trained test pilots performed realistic duties during simulations of three missions. The areas evaluated include: duty cycles, physical conditioning of crew members prior to and during the mission, crew proficiency in normal mission duties, and crew alertness to emergency situations. The study showed no difficulties with test-pilot personnel for confinement periods up to 7 days. It was found that a 26-hour duty cycle with two 4-hour sleeping periods was suitable for a three-man crew on a 7-day mission, and that there was no decrement in performance resulting from the long mission time. Because of the onboard exercise program, there was no deterioration of physical condition, and the pilots' alertness remained high throughout the mission. Author

N63-12968 George Washington U. Human Resources Research Office, Washington, D.C.

LOW ALTITUDE AERIAL OBSERVATION: AN EXPERIMENTAL COURSE OF INSTRUCTION

Francis H. Thomas Oct. 1962 71 p 6 refs

(Contract DA-44-108-ARO-2)

(HumRRO-TR-80)

A field test, in which combat situations were simulated, was administered to aerial observers as a means of identifying the basic skills involved in low altitude aerial observation. The main skill areas were found to be visual search, target recognition, geographical orientation, and target location. Methods and techniques for teaching the identified skills were developed and evaluated in five field experiments, and the productive procedures were incorporated in an aerial-observer training course. In a final evaluation, students trained under the experimental course performed as well as experienced observers who had been trained in the conventional program. Author

N63-12969 George Washington U. Human Resources Research Office, Washington, D. C.

TRAINING MATERIALS FOR AERIAL OBSERVER INSTRUCTION IN BASIC VISUAL SKILLS

James M. Hesson and Francis H. Thomas Fort Rucker, Ala., Army Aviation Human Res. Unit, Oct. 1962 93 p 2 refs

(Supported by Dept. of Army Contract)

(HumRRO-TR-80, Suppl.)

A training "package" on the basic skills of visual aerial observation is presented covering the following: visual search techniques, recognition training, geographical orientation, and target location. J.R.C.

N63-13083 George Washington U. Human Resources Research Office, Washington, D.C.

QUARTERLY RESEARCH REPORT, OCTOBER—DECEMBER 1962

J. Daniel Lyons Ft. Rucker, Ala., Army Aviation Human Resources Res. Unit, Dec. 31, 1962 18 p refs

(Contract DA 44-188-ARO-2)

Army-aviation helicopter pilot-training, aerial-surveillance personnel training, integrated contact/instrumentation-training, navigation-training for low level flight, aerial-gunnery training in the armed helicopter, and guidance for establishing requirements and characteristics of training devices are reviewed. I.v.L.

N63-13084 George Washington U. Human Resources Research Office, Washington, D.C.

TRAINING RESEARCH ON LOW ALTITUDE VISUAL AERIAL OBSERVATION: A DESCRIPTION OF FIVE FIELD EXPERIMENTS Research Memorandum No. 8

Francis H. Thomas and Paul W. Caro, Jr. Ft. Rucker, Ala., Army Aviation Human Resources Res. Unit, July 1962 79 p 5 refs

(Supported by the Army)

Five field experiments were conducted in research on aerial-observation training of human beings. The experiments were as follows: (1) comparing the effectiveness of four visual-search methods; (2) and (3) relating classroom speed-of-recognition training to inflight observation performance; (4) improving the ability of the observer to remain geographically oriented while in flight; and (5) improving the accuracy with which the airborne observer can locate the position of ground targets on his map. Results of the experiments were: (1) the side-movement procedure produced the highest level of identification performance; (2) and (3) the influence of classroom recognition training upon field-test performance was not evident; (4) observer geographical orientation is related to target location accuracy; and (5) the level of performance achieved in classroom geographical-orientation training is associated with a comparable level of inflight target-location accuracy. D.B.

15 INSTRUMENTATION

Includes: design, installction, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; and sensors and transducers.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

N63-12935 Argonne National Lab., Ill.

HIGH-TEMPERATURE SENSORS FOR BORAX-V BOILING FUEL RODS

E. J. Brooks, W. C. Kramer, and R. D. Mc Gowan Oct. 1962 41 p 21 refs

(Contract W-31-109-eng-38)

(ANL-6636)

High-temperature sensors are developed to measure characteristics of nuclear-reactor-fuel and -coolant systems. The sensors measure the temperatures to 2760° C in the center of the UO_2 boiling-fuel rods. These high temperatures occur when the low thermal conductivity of the UO_2 fuel is combined with cases of flux peaking, low coolant flow, and maximum design power. Thermocouples provide a means for measuring fuel temperature as a function of reactor power. Evaluation of eight production thermocouples has shown that the maximum temperature which can be measured accurately is approximately 2200° C. The limiting factor is the temperature at which a reaction between BeO and tantalum begins. J.R.C.

N63-12937 Du Pont de Nemours (E. I.) and Co. Savannah River Lab., Aiken, S.C.

A GASEOUS SCINTILLATION COUNTER WITH GAS MULTIPLICATION

Fred H. Giles, Perry Sprawls, Jr. (M. S. Thesis–Clemson Coll., 1960), and LeConte Cathey Nov. 1962 26 p 12 refs

(Contract AT(07-2)-1)

(DP-800)

Although signal gains of up to 225 were obtained for gaseous scintillation pulses by application of an electric field as in proportional counter operation, the attainable signal level and corresponding energy resolution were inferior to that achieved by standard crystal scintillators or proportional counters. The method might have some application in analysis of low energy X-rays, if the collection and detection of light could be improved. Author

N63-12942 California U., Berkeley. Lawrence Radiation Lab.

MAGNETIC ANALYSIS OF ATOMIC AND MOLECULAR BEAMS. I. CONSTRUCTION AND CALIBRATION OF INHOMOGENEOUS DEFLECTING MAGNETS

Ronald R. Herm and Dudley R. Herschbach Oct. 1962 41 p 17 refs

(Contract W-7405-eng-48)

(UCRL-10526) OTS: $1.00

Three small iron-core electromagnets have been constructed. The overall dimensions of the largest magnet (denoted by A) are about 5 × 5 × 5-in. and the airgap is 0.10-in. wide, 0.15-in. high, 4.5-in. long. The other magnets (B and C) are shorter and have wider airgaps. The pole tips conform to the cylindrical magnetic equipotential surfaces of the field produced by a pair of infinitely long parallel wires carrying equal and opposite currents. Forty-two turns of 0.18-in. I.D. copper water tubing carry an energizing current of up to 100 amp which is provided by a transistorized power supply allowing only 0.2% ripple at 100 amps. The efficiency of the magnet design was investigated by measuring the flux through the airgap and various cross sections of the magnet yoke as a function of the energizing current. Magnet A exhibited a peak induction at the midpoint of the gap of about 15 kilogauss, with a transverse gradient of 90 kilogauss/cm. For magnets B and C the peak induction observed was about 10 kilogauss, with a gradient of 30 kilogauss/cm. Author

N63-12951 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

CALIBRATIONS AND COMPARISONS OF PRESSURE-TYPE AIRSPEED-ALTITUDE SYSTEMS OF THE X-15 AIRPLANE FROM SUBSONIC TO HIGH SUPERSONIC SPEEDS

Terry J. Larson and Lannie D. Webb Washington, NASA, Feb. 1963 37 p 28 refs

(NASA TN D-1724) OTS: $1.00

The X-15 flight calibration data to define static-pressure position errors are presented for two types of pressure-sensing configurations: a standard NACA pitot-static tube attached to a nose boom, and two manifolded flush static-pressure ports on the ogive nose. The position-error calibrations are presented up to M = 3.31 for the standard nose-boom installation and to M = 4 for the flush static system. Presented also are stagnation-pressure errors sensed by a pitot probe ahead of the canopy. Methods used to determine the position errors are described. The nose-boom configuration is shown to be superior from the standpoint of position error and ease of calibration for the available data range. Author

N63-12966 Naval Ordnance Lab., Corona, Calif.

INTERPRETATION OF PHOTODETECTOR PARAMETERS

J. D. Merriam and W. L. Eisenman Jan. 15, 1962 27 p 4 refs

(*Its* Photodetector Ser., 49th Rept. NOLC-558)

The parameters and figures of merit used by NOLC in evaluating photodetectors are defined and interpreted. In order to make the data reported in the NOLC photodetector series of reports more useful, a method is given for determining a photodetector's behavior under conditions other than those measured and reported. Author

N63-13008 Rome Air Development Center. Applied Research Lab., Griffiss AFB, N. Y.

FLOW CALORIMETERS FOR THE 4-MM AND 2-MM WAVELENGTH RANGE

Vincent C. Kapfer Dec. 1962 30 p 7 refs

(RADC-TDR-62-600)

Present commercial calorimeters operating at wavelengths below four millimeters are limited to the measurement of a maximum of one-half watt of average power, thus requiring the use of precision calibrated attenuators for higher powers. This report describes the mechanical and electrical characteristics of a 4-millimeter (50 to 75 kmc/s) and a 2-millimeter (90 to 140 kmc/s) flow calorimeter capable

of measuring several watts of average power. These calorimeters have an advantage over commercially available units by being capable of direct power measurements from one milliwatt to several watts without the use of auxiliary components. Author

N63-13012 Navy Electronics Lab., San Diego, Calif.

INTERLEAVED-PLATE ELECTRODYNAMIC TRANSDUCER. PART III: DESIGN AND PERFORMANCE OF MODEL 3B Research and Development Report [September 1960-December 1962]

F. R. Abbott Dec. 20, 1962 17 p

(NEL-1151)

The transducer described in Part II of this series of reports (NEL Report 995) was modified to prevent flexure of the driving plates and water stoppage in constricted sections. Design details and operating characteristics of the revised model are described. Author

N63-13033 Research Triangle Inst. Measurement and Controls Lab., Durham, N. C.

INVESTIGATION OF THE PROPERTIES OF A TUNABLE RESONANT GALVANOMETER AS APPLIED TO THE SUB-AUDIO FREQUENCY RANGE Final Report

J. J. Wortman and Ralph L. Ely, Jr. Oct. 31, 1962 31 p

(Grant DA-ARO(D)-31-124-G281)

Several forms of an electrically tunable version of the resonant galvanometer have been studied with particular attention to the characteristics in the frequency range from 0.1 to 10 c/s. One version, the pivoted coil, has an undamped Q of 50f and a vibration amplitude that is proportional to the input signal and independent of the resonant frequency over the range studied (0.1 to 10 cps). The Q may be reduced by introducing mechanical damping. A suspended coil version and two ferrite vibrators also exhibited high Q's but the amplitude of vibration at resonance was not independent of the resonant frequency. However, these versions would be entirely suitable for fixed-frequency work. Author

N63-13044 Oklahoma State U. Research Foundation, Stillwater

SECTION C, PHYSICAL SCIENCES. ROCKET-BORNE INSTRUMENTATION EQUIPMENT FOR IONIC CONDUCTIVITY STUDIES IN THE UPPER ATMOSPHERE

Oscar L. Cooper Repr. from Proc. Okla. Acad. Sci., v. 42, 1962 p 164-171

(NASA Contract NASw-159)

The payload instrumentation for ionic conductivity studies of the upper atmosphere, which was provided for the two Aerobee-100 rockets launched in November 1960, in Manitoba, Canada, is described. Each payload consisted of a nose cone instrumentation rack accommodating the electronic equipment and control circuits, and two cylindrical Gerdien condensers mounted on the forward tips of the nose skins. Each condenser housed a polarized conductivity-measuring electrode. Both rockets performed well, and all of the instrumentation appeared to function satisfactorily. However, reduction of the telemetry data is incomplete. M.P.G.

N63-13048 Aberdeen Proving Ground. Ballistic Research Labs., Md.

MECHANICAL IMPULSE MEASUREMENTS CLOSE TO EXPLOSIVE CHARGES

J. M. Dewey, O. T. Johnson, and J. D. Patterson, 11 Nov. 1962 23 p 10 refs

(BRL-1182)

A mechanical plug gage is used for measuring "face-on" impulse in air blast close to spherical Pentolite explosives detonated in air at different ambient pressures. The data are compared with previous results. The study indicates that at small distances ($Z < 1.5$ ft/lb$^{1/3}$) the change in normally reflected impulse with variation in ambient pressure is negligible; it further suggests that the measured impulse, within several charge radii, of the explosive is due to the flow of the explosion gases and that the interchange of impulse between positive and negative phases is small. Author

N63-13088 Ohio State U. Research Foundation, Columbus

AN INTERFEROMETRIC-MODULATION ORDER-SEPARATOR FOR A FAR INFRARED SPECTROGRAPH Scientific Report No. 3

Miles Elliot Vance (Ph. D. Thesis) Sept. 1962 195 p 29 refs

(Contract AF 19(604)-4119)

(AFCRL-62-1008)

An interferometric modulator is designed primarily for use with a far infrared grating monochromator. The type of interferometric modulation used may be described in essence as a wavelength dependent modulation of radiation intensity by two-beam interference. The modulator obtains greatest radiation-gathering power when the interferometer plates, or beam-splitter, have rotational symmetry and consist of semitransparent plates. If detectors with significantly larger receiver areas and solid angles become available, the interferometer may be more easily enlarged to take advantage of them. Interferometric filtering is expected to be more efficient than the conventional reststrahlen and transmission filters. The convenience of the modulator-spectrometer combination is in having a source of uniformly pure radiation in the range 100μ to 1000μ, with immediate recording of the spectrum and with the possibility of immediate comparison of signals with and without samples. J.R.C.

N63-13090 Rensselaer Polytechnic Inst. Plasma Research Lab., Troy, N.Y.

A PLASMA WAVEGUIDE CELL FOR AFTERGLOW MEASUREMENTS Technical Report No. 5

E. H. Holt and K. C. Stotz July 1962 10 p 9 refs Submitted for Publication

(NASA Grant NsG-48-60)

OTS: $1.10 ph, $0.80 mf

A plasma waveguide cell has been devised for microwave study of plasma afterglows. The geometry of the waveguide was arranged to simplify calculations of dielectric properties, e.g., the dielectric fills a given section of rectangular waveguide of standard dimensions. This waveguide cell has been used to check the values of the ambipolar diffusion coefficient in helium (D_aP = 730cm^2/sec) which agree with the values obtained by Kerr and Leffel (D_aP = 697cm^2/sec.). R.C.M.

N63-13113 Directorate of Engineering Test, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

A CONTRIBUTION TO THE THEORY OF SCHLIEREN SENSITIVITY AND QUANTITATIVE EVALUATION [Final Report]

Lee Kean Dec. 1962 40 p 17 refs

(ASD-TDR-62-924)

Detectors used to evaluate schlieren images have a response proportional either to the illumination or to the logarithm of the illumination. Sensitivity point functions appropriate to both kinds of response are defined analytically. These functions are well defined even in the presence of optical system imperfections and are not referenced to the clear field illumination. By the choice of an appropriate system configuration, either function can be reduced to a constant. It is shown that, in principle, the light deviation values required for quantitative evaluation can be found by subtracting out the illumination increments due to diffraction and other system errors. A qualitative treatment of schlieren diffraction from the point of view of the Thomas Young theory is given. A technique is described for obtaining a stigmatic source image with an offset two-mirror schlieren system. A simple method for obtaining simultaneous vertical and horizontal knife-edge schlieren pictures is given. A means for magnifying sensitivity without the use of long focal length mirrors is described. A new method for measuring gas temperatures, which involves crossing a color schlieren system with a spectrograph, is described. Author

N63-13125 Michigan U. Radiation-Solid-State Physics Lab., Ann Arbor

PART IV. SOLID STATE INSTRUMENTATION

Glenn G. Sherwood *In its* Microwave Interactions of Crystal Defect Centers Final Report Jan. 1963 p 178-191 2 refs (See N63-13121 07-23)

Design and development of a dE/dx detector to be used in a proton recoil telescope spectrometer is discussed. After the silicon crystal has been prepared, the back of the crystal is protected by wax while the entire holder is immersed in an etch bath (nitric acid, hypofluoric acid, and acetic acid in volume proportions 2:1:1) for two minutes. After washing in distilled water, the wax is removed from the back. After 24 hours, 75 micrograms/cm² of gold is evaporated on the front and the same quantity of aluminum is evaporated on the back. The important aspect of this technique is that the etch rate has been controlled without any apparent preferential action on the part of the etch solution. Using this procedure on the face of the silicon crystal apparently provides the density of fast states necessary for the inversion layer. With the evaporation of a gold layer, the rectifying junction appears to be complete. Test results indicate at least a partial success with the new semiconductor dE/dx detectors and some success with the telescope. I.v.L.

N63-13220 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A VACUUM ULTRAVIOLET PHOTOIONIZATION DETECTOR

A. K. Stober, R. Scolnik, and J. P. Hennes Washington, NASA, Mar. 1963 11 p 15 refs

(NASA TN D-1715) OTS: $0.50

A small ceramic ion chamber has been developed for a rocket astronomy program in the vacuum ultraviolet. The chamber consists of a small metal plated ceramic shell incorporating a window of LiF, CaF_2 or BaF_2 and containing one of several fill gases such as nitric oxide, acetone, or carbon disulfide. Typical quantum efficiencies range from 8 to 10 percent for acetone with a CaF_2 window to 50 to 60 percent for carbon disulfide with a LiF window. Details of the chamber construction are given, and some recent applications of the detector are described. Author

N63-13230 Army Missile Command. Guidance and Control Lab., Redstone Arsenal, Ala.

MISSILE ATTITUDE DETERMINATION USING MAGNETOMETERS WITH SUN AND EARTH SENSORS

C. F. Asquith and W. F. Baxter Dec. 31, 1962 28 p 1 ref (RG-TR-62-5)

Several methods for determining missile attitude are defined. The methods described are based on the use of on-board equipment which responds to references present in nature rather than on-board equipment which actually establishes a reference. The sensor combinations dealt with are the magnetometer-sun sensor and magnetometer-earth sensor combinations. Author

N63-13239 Magna Corp. Research and Development Labs., Anaheim, Calif.

AN ELECTRICAL CONDUCTANCE TEST METHOD FOR MEASURING CORROSION

David Roller *In* Library of Congress. Science and Technology Div., Washington, D. C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 69-88 21 refs (See N63-13234 07-01)

A test method has been developed for determining the rate and amount of corrosion of a metal specimen by measuring the specimen's change in electrical conductance. The primary advantages of this method over conventional methods include the following: specimen cleaning is unnecessary; it can be used in any corrosive environment; and measurements are simple, rapid, and precise when corrosion is generally uniform. Statistical analysis showed that the initial test results were comparable to results obtained by conventional methods. R.C.M.

N63-13290 Aeronautical Research Labs., Melbourne (Australia)

AN EXPERIMENTAL SELF TEMPERATURE COMPENSATED STRAIN GAUGE SYSTEM

L. G. Randell July 1962 35 p 8 refs

(ARL/Mechanical Engineering Note 251)

An experimental self-temperature-compensated strain-gage system for measuring static strains under changing temperature conditions for the temperature range +150° C to -196° C is described. The effect of temperature gradient on the gage and compensating element is explained. A description is given of the manufacture and testing of the strain gage and associated bridge network, together with experimental results showing the temperature compensation achieved. The effect of temperature on the strain sensitivity of the system as a whole is discussed. Attention is drawn to some of the practical aspects of using the gages and bridge network under field conditions. Author

N63-13303 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

PROPOSAL FOR DETERMINING THE MASS OF LIQUID PROPELLANT WITHIN A SPACE VEHICLE PROPELLANT TANK SUBJECTED TO A ZERO GRAVITY ENVIRONMENT

R. L. Evans and J. R. Olivier Washington, NASA, Mar. 1963 11 p (NASA TN D-1571) OTS: $0.50

A liquid-propellant mass-measurement system is proposed for the zero-gravity environment. The known thermodynamic relationships for the liquid propellant and an inert gas are used in conjunction with state-of-the-art instrumentation to provide a system comparable with terrestrial mass-measurement systems. In particular, the operation of the system is outlined for the propellant transfer method and for the determination of leaks and leakage rates. A second concept—a simplified version of the proposed mass-measurement system—is introduced and discussed. Author

16 LIFE SCIENCES

Includes: biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness.

For related information see: 14 Human Behavior; and 28 Space Radiation.

N63-12844 National Academy of Sciences, Washington, D.C.

IMPACT ACCELERATION STRESS. A SYMPOSIUM HELD AT BROOKS AIR FORCE BASE, SAN ANTONIO, TEXAS, NOVEMBER 27-29, 1961 [UNDER THE AUSPICES OF THE MAN IN SPACE COMMITTEE OF THE SPACE SCIENCE BOARD, NATIONAL ACADEMY OF SCIENCES]

Robert Hume, ed. 1962 494 p 1152 refs Contains a comprehensive chronological bibliography

(Supported by NASA Grant, AF, and Navy)

(NAS-NRC/Pub-977) Available from NAS: $3.00

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N63-12845 National Aeronautics and Space Administration, Washington, D.C.

REVIEW OF NASA IMPACT WORK AND PLANS

Alfred M. Mayo *In* Natl. Acad. of Sci. Impact Acceleration Stress A symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 5-15 (See N63-12844 07-16) NAS: $3.00

The needs of limited-impact research to meet orbital rendezvous, lunar-landing, and earth-landing requirements of the Apollo project are presented. Particular emphasis is placed upon the determination of human-tolerance impact along body axes, other than the normal horizontal, vertical, and transverse axes. I.v.L.

N63-12846 Department of the Army. Office of the Surgeon General, Washington, D.C.

REVIEW AND FORECAST OF IMPACT STUDIES—UNITED STATES ARMY

Anthony A. Bezreh (Army Board for Aircraft, Ft. Rucker, Ala.) and James C. Beyer *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 17-20 (See N63-12844 07-16) NAS: $3.00

A review and forecast of impact studies of the United States Army are presented. One of the major facilities that the Army has for coping with aeromedical problems, such as injuries and fatalities due to aircraft accidents, is the United States Army Board for Aviation Accident Research. The contribution of this organization on the impact-deceleration problem is made through an empirical approach involving analysis of Army aviation-accident reports and firsthand crash-injury investigations. In an attempt to exactly establish the forces that have to be dealt with in light aircraft accidents, the Army's Transportation Research Command contracted with Aviation Crash Injury Research, a division of the Flight Safety Foundation, to conduct carefully monitored, instrumented drop-tests. In this program, light aircraft are purposely crashed under control conditions, and the resulting forces are quantitatively and qualitatively measured with respect to magnitude, direction, frequency, rate of onset, and other variables that are important in the production of crash injuries, in the development of protective equipment, and in the design of crashworthy aircraft structures. I.v.L.

N63-12847 Federal Aviation Agency, Washington, D.C.
FEDERAL AVIATION AGENCY IMPACT RESEARCH
James L. Goddard *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 21-23 (See N63-12844 07-16) NAS: $3.00

The research activities of the Federal Aviation Agency in the field of impact acceleration stress are discussed. These research activities can be listed in three major categories: (1) the further determination of human tolerance to impact forces; (2) the further determination of forces transmitted to the occupants of current civil aircraft during crash impacts; and (3) the further development of crash safety designs which can contain the crash forces transmitted to aircraft occupants at levels below the maximum tolerance level. I.v.L.

N63-12848 Lasarette, Orebro (Sweden)
BIOMECHANICAL PROBLEMS OF THE LUMBAR SPINE
Olof Perey *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 25-26 (See N63-12844 07-16) NAS: $3.00

Fracture of the vertebral column was investigated. Two or three vertebrae with intervening disks from a great number of individuals were studied. Both static- and dynamic-stress were employed. Results indicated that: (1) There was a great biological variation on the vertebral breaking-point. The breaking-point with individuals over 60 years old was much lower than in younger groups. The average values in the group over 60 years was much lower than in younger groups. The average values in the group over 60 years old was 425 kp. In individuals under 40 years old, the breaking-point varied between 500 kp and 1,100 kp, with an average value 790 kp. In one-third of the specimens fracture of the end plates was observed. These fractures were divided into three different types: (a) fractures centrally in the end plate, (b) fracture of the end plate situated so far peripherally that a corner of the vertebral body was torn loose, and (c) fissure extending across the entire end plate which, when deepened to involve the whole vertebral body, divided it into two parts. This is the first stadium of the common compression fracture. An accessory finding was that: (1) The osteophytes are very fragile, fracturing even for 100 kp to 150 kp; (2) The real strength of the vertebral arches and the articular process takes only 20% of the weight imposed; and (3) The lumbar vertebrae can stand a static stress of 800 kp or a dynamic stress during 0.006 sec of 1,300 kp. These values are quite low and indicate that the erector trunci and abdominal muscles take part in the weight-bearing. I.v.L.

N63-12849 National Aeromedical Center, Soesterberg (Netherlands)
THE PHYSIOLOGIC ACCELEROMETERS
M. P. Lansberg *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 27-34 (See N63-12844 07-16) NAS: $3.00

Physiological accelerometers under conditions of weightlessness were investigated. Three inherent contradictions existing are that (a) the head is held in an inclined position relative to the vertical, (b) the head is rotating around a horizontal axis, and (c) the head is moved along a horizontal path. During weightlessness, it will be man's visual framework that will induce his spatial orientation. Against this background, the three contradictions arise. In the situation where the head is held in an inclined position relative to the vertical, the otoliths signal a symmetric status, albeit a symmetry of zero gravity, and for the higher centers a symmetry means perpendicularity, which is denied by the visual reference. Probably the voice of the otoliths will not be very strong in this instance, and the visual clue will dominate. The reason is that the otoliths respond to change in acceleration rather than to acceleration. In the situation where the head is rotating around a horizontal axis, matters become worse. There is not only a conflict between otolithic information and visual framework but, worse still, the semicircular canals report a change in attitude which should be corroborated by the message from the otoliths which, however, may default. A disagreement now develops between the two parts of the labyrinth. This disagreement would not arise if the head movement had occurred around a vertical axis, vertical in the man's subjective framework of orientation. The situation where the head is moved along a horizontal path will probably be of less importance because such linear movements do not seem likely to occur. I.v.L.

N63-12850 Centre d'Enseignement de Recherches de Medecine Aeronautique, Paris (France)
FRENCH OBSERVATIONS AND RESEARCH CONCERNING IMPACT AND CRASH
Francois Violette *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 35-37 (See N63-12844 07-16) NAS: $3.00

Observations and research results of the French Air Force Medical Corps on impact and crash include the following: (1) For wounded patients that are carried with feet forward on longitudinally set stretchers, two straps are sufficient—one on the base of the thorax, the other on the middle of the thighs. These straps, usually moderately tightened, must be sufficiently tightened in case of crash to prevent any slipping of the wounded on the stretcher. The restraint may be comfortized: (a) with stoppers placed on the arms of the stretchers, and (b) by broadening the straps (three inches or 7.5 cm). A release-pin system is recommended for quick strap release. (2) The telescopic ejection seat is superior to the ejection seats with solid axis guns. Also, the breaking-joint of the spine was about the seventh thoracic vertebra. In addition, a helmet chinstrap in high-speed ejection is both useless and dangerous. (3) In the emergency ditching of a helicopter, the impact shock on the cabin floor was not felt by the standing crew members; nevertheless, the pilot and copilot both received spinal fractures although well strapped. In such accidents the impact deceleration may be transmitted without softening from the floor to the seat and to the strapped subject. I.v.L.

N63-12851 Flight Safety Foundation, Woods Hole, Mass.
AVIATION CRASH INJURY RESEARCH—REVIEW OF THE FLIGHT SAFETY FOUNDATION IMPACT WORK AND PLANS
Merwyn A. Kraft *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 39-43 (See N63-12844 07-16) NAS: $3.00

Flight Safety Foundation impact work encompasses: (1) On-the-scene investigation of military and civilian, fixed-wing and rotary-wing accidents; (2) statistical analysis of data for the purpose of determining injury-causitive factors; (3) trend analysis of accident rates, injury severity rates, installation and utilization of safety equipment, and structural design features related to injuries; (4) medical studies of the frequency and pattern of injuries; (5) specialized training in the art and techniques of aircraft accident investigation with emphasis on crash injury and survival; (6) human factor studies where information relative to injuries and causative agents is correlated and interpreted in a clinical manner with emphasis on occupant restraint, occupant environment, protective equipment, and emergency evacuation; and (7) the conduction of full-scale crash tests of aircraft and the dynamic testing of components. I.v.L.

N63-12852 Cornell U. Automotive Crash Injury Research, New York, N.Y.
CAUSES OF IMPACT INJURY IN AUTOMOBILE ACCIDENTS
Robert A. Wolf *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 45-59 2 refs (See N63-12844 07-16) NAS: $3.00

A ranking procedure which provides a measure of the order of importance of ten causes of impact injury in automobile accidents is presented. The causes are discussed in terms of their variation with six categories of impact: all directions lumped, then front, side, rear, principal rollover, and other. Five of the ten features of automobile interiors emerge as consistent major causes of injury. They are: instrument panels, windshields, steering assemblies, door structures, and ejection. Some other causes appear dominant only under certain

directions of impact; for example, top structures emerge as a strong cause only in rollover. These results are based on accident-injury experience in the pre-seat-belt era in the United States. The ranking procedure used here is not a substitute for detailed and controlled analysis, as it is essentially a tabulation process, but it has several important uses: (1) It provides an overview of the type of research which Automobile Crash Injury Research performs. (2) It provides some indication of an order or priority for automobile designer in his efforts toward building safer cars. (3) It provides clues for guidance of further study and research. I.v.L.

N63-12853 Wayne State U., Detroit, Mich.

HUMAN AND ANIMAL IMPACT STUDIES IN U.S. UNIVERSITIES

Herbert R. Lissner *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 61-67 (See N63-12844 07-16) NAS: $3.00

Human and animal impact studies in U. S. universities deal with the following three categories: (1) programed automobile crashes, either actual or simulated; (2) investigations of actual on-the-road automobile crashes after they have occurred; and (3) laboratory investigations which attempt to relate the extent and severity of the injury produced to the parameters of the impact responsible for the injury. I.v.L.

N63-12854 Ford Motor Co. Product Study Engineering Office, Detroit, Mich.

AUTOMOTIVE IMPACT

A. L. Haynes *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 69-82 (See N63-12844 07-16) NAS: $3.00

An outline is presented for some of the techniques employed for obtaining factual data on automotive impacts. These research studies have been conducted as part of an ever-expanding program to develop design features and methods for reducing occupant injuries in actual accidents. Some values of human tolerance to impact forces have been estimated by comparisons of actual accidents and occupant injury with the force and kinematic data obtained in research impact studies. Techniques have been developed for predicting the loading patterns and structural behavior characteristics which can be anticipated under particular crash-impact conditions. However, much less is known about the human response to impact loading. Studies in this field are underway at various medical centers, frequently with the financial sponsorship of automobile manufacturers. Statistical analysis of accidents involving late model cars have demonstrated that at reduction in occupant injuries already has been achieved. I.v.L.

N63-12855 Stanley Aviation Corp., Denver, Colo.

IMPACT STUDIES OF THE UNITED STATES AEROSPACE INDUSTRY

Galen A. Holcomb *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 83-119 31 refs (See N63-12844 07-16) NAS: $3.00

A survey of impact studies of the United States aerospace industry indicated the following needs: (1) Further animal studies and experiments, including a comprehensive study of comparative anatomy and tissue strength, to obtain valid endpoint data without the use of human subjects. Present human endpoint data in the impact regime is too sparse to be of statistical significance. (2) Studies to determine tolerance to complex accelerations, including abrupt pulses superimposed on sustained acceleration. (3) Intensive analytical studies to evolve usable mathematical techniques in order to facilitate design and reduce long, costly test-programs. I.v.L.

N63-12856 Aeronautical Systems Div. Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio

BIOMECHANICS OF IMPACT INJURY

Henning E. von Gierke *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 121-122 (See N63-12844 07-16) NAS: $3.00

A review of the biomechanics of impact injury indicates that: (1) Steady-state vibration studies are very helpful for interpreting impact tolerance data. The mechanical models for the human body derived from such studies are useful as a basis for theoretical analysis and prediction of impact response. (2) Theoretical analysis of the response of the complex human system to impact loads shows clearly that a complete description of the force-time function of the impact load is necessary to define response or tolerance uniquely. Only in very limited impact-duration ranges can a single parameter such as peak acceleration, impulse, or rate-of-onset be considered primary to the response. I.v.L.

N63-12857 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.

JOLT EFFECTS OF IMPACT ON MAN

John P. Stapp *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 123-130 (See N63-12844 07-16) NAS: $3.00

A survey of jolt effects of impact on man indicated that any attempt at stress analysis of man with respect to impact forces must take into account the responses of the body as a whole; the simultaneous responses of different kinds and different states of materials in body structure, such as the pneumatic and hydraulic behavior of gases and fluids; plastic deformation of soft tissues; and the stretching of the mesenteries and ligaments by displacement or organic masses. Since the object of human stress analysis is to determine reversible and irreversible, disabling and fatal criteria of the human structure, it is well to relate measurements to points of structural weakness or load concentration. I.v.L.

N63-12858 Michigan U., Ann Arbor

BIOMECHANICAL STUDIES ON THE BONES OF THE FACE

Donald F. Huelke *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 131-133 11 refs (See N63-12844 07-16) NAS: $3.00

Results of biomechanical studies on the bones of the face indicate that bone fractures are due to tensile failure. The bones are being stretched and fail due to tension, not to compression. In the lower jaw the following, in general, can be expected: fracture of the jaw at the point of impact and at the narrow area of the mandible (the subcondylar area), the region just below the temporomandibular joint. These generalizations agree with and reinforce the findings on other body parts (the skull, thigh bones, spinal column, and pelvis) that fractures are produced due to high tensile strain within the bone. One cannot reinforce these body structures from the inside, therefore, protection must come from without. To do this, the amount of energy absorbed by the facial bones must be decreased. This can be done by protecting the face by some sort of energy dissipating "mask," by restraining the head and body to prevent impact against objects, or by covering possible impact surfaces and objects with energy dissipating material. Each of these methods of protection has its own application and rarely will all three be used simultaneously. I.v.L.

N63-12859 Harvard U. Medical School, Boston, Mass.

STEERING WHEEL IMPACT

Murray Burnstine *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 135-139 1 ref (See N63-12844 07-16) NAS: $3.00
(PHS Grant RG-6084)

The manner in which various automobile steering wheels have been observed to function as either injury-producing or protective structures is studied. The steering wheels were first studied at the scene of fatal collisions, where their deformation and deviation from the installed position was recorded. The steering wheels and often the complete steering-wheel mast-jacket assemblies were subsequently

removed for more detailed laboratory analysis. Results indicated that the recessed-hub steering-wheel design functions as a load-limiting device while yielding. Its effectiveness is due in part to the ability of the human body to deform and distribute the total load among adjacent structures. When the load application is through the relatively large circumference rim as compared to the hub, the resulting shearing stress is reduced considerably. Bruising, due to local high unit bearing or contact pressures, can be reduced by increasing the projected area of the steering wheel rim. Most of the energy absorption characteristics of the wheel assembly are dependent on spoke design, and a thicker rim would reduce contact pressures for both the axial- and radial-impact modes. I.v.L.

N63-12860 General Motors Corp. Research Labs. Div., Detroit, Mich.

CRITERIA FOR INJURY POTENTIAL

Charles W. Gadd *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 141-144 3 refs (See N63-12844 07-16) NAS: $3.00

Criteria for injury potential of automotive instrument-panel paddings, visors, projections, etc., is presented. The three criteria for injury potential are: (1) the selection of a crushable material on the basis of its load deflection properties, obtained at some arbitrary rate of loading and unloading; (2) the rate of loading which may be taken into account only by selecting test impacting hammer velocity or velocities most representative of actual accidents, for which one must resort to statistics of accidents as well as studies of car and occupant kinematics in the accident; and (3) the yielding and energy absorption of the underlying or surrounding structure. I.v.L.

N63-12861 Wayne State U., Detroit, Mich.

EXPERIENCES IN HEAD INJURY AND SKELETAL RESEARCH

E. S. Gurdjian *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 145-157 9 refs (See N63-12844 07-16) NAS: $3.00

The mechanism of skull fracture and concussion has been outlined. Strength characteristics of various bones in the body have been studied. Effects of embalming on the strength characteristics of bone have been evaluated. Impact tests upon the femur, pelvis, and spine have been conducted, and the results summarized. Recent studies on cadaver-head impacts into safety glass are briefly analyzed. Author

N63-12862 Michigan U., Ann Arbor

IMPACT DAMAGE TO INTERNAL ORGANS

Lawrence M. Patrick (Wayne State U., Detroit) and F. Gaynor Evans *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 159-171 7 refs (See N63-12844 07-16) NAS: $3.00

(PHS Grants RG-A-3865(C2) and RG-6384(C2))

Contusions, lacerations, and ruptures of the thoracic, abdominal, and pelvic viscera, arising from the various types of stresses and strains produced by impacts to different parts of the human body in automobile and aircraft accidents, are discussed. Results indicate that damage or injury produced in the human body by acceleration is due to the internal organs behaving as viscoelastic materials. Furthermore, the magnitude of the stress and acceleration, or dynamic response, can be increased by the elasticity of the human torso, as is known from the theory of elastic structures. I.v.L.

N63-12863 Aeronautical Systems Div. Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio

COMPARISON OF THE DYNAMIC CHARACTERISTICS OF DUMMIES, ANIMALS AND MAN

Rolf R. Coermann *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 173-184 6 refs (See N63-12844 07-16) NAS: $3.00

Man, animals, and dummies have different dynamic characteristics which can be determined by measurement of the mechanical impedance under steady-state vibration. While the parameters of the dummies are constant for a wide range of acceleration amplitude and pulse duration, the response of living organisms depends upon the magnitude of the applied force. The theory of impact explains the relationship of whole-body resonances to the response to impacts with varying pulse durations. By measuring the transmitted force to the body during impact, the change of the fundamental frequencies of the test subject can be detected. Transmission factor and phase shift are revealing criteria of this test method. Before using substitutes for man in dynamic tests, their dynamic characteristics for the type of excitation studied must be carefully tested, and any conclusion from such a dynamic test must be related to the proper parameters of man. I.v.L.

N63-12864 David Taylor Model Basin, Washington, D.C.

A COMPARISON OF THE RESPONSES OF MEN AND DUMMIES TO SHIP SHOCK MOTIONS, PART 1 AND 2

Arthur E. Hirsch *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 185-190 (See N63-12844 07-16) NAS: $3.00

Responses of men and dummies to ship shock motions were compared. Results indicate that: The motion of the center of gravity of the dummy in the stiff-legged stance is very close to that of man; in the bent-knee stance the dummy does not simulate man's motion; and motions of the seated man and dummy are not too different. In this latter case it is possible that with a better dynamic match of buttock material, e.g., if beefsteak is substituted for the existing sponge rubber, the results for the seated position may be as good as for the stiff-legged stance. I.v.L.

N63-12865 Stanley Aviation Corp., Denver, Colo.

A MINIMAL COMPRESSION FRACTURE OF T-3 AS A RESULT OF IMPACT

Galen A. Holcomb and Marilyn Huheey *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 191-194 (See N63-12844 07-16) NAS: $3.00

A human being was placed in the B-58 escape capsule and ground impact was simulated as it would occur during landing on either dry compacted soil or water in high wind situations. This simulation was accomplished by suspending the B-58 capsule from a monorail, propelling the capsule down the rail at the desired speed, and releasing the capsule over the desired type of surface. The capsule's normal landing attitude, which places the man in a pseudofetal position lying on his back, was utilized in all biological tests. The orientation about the X-axis could be varied so that the subject was traveling down the rails head forward, feet forward, or side forward. Four drop tests were performed. There were two water drops and two dirt drops. The first drop consisted of a head forward, 23 mph test from a height of 9 ft. 9 in. onto water. The second was a side forward water drop (23 mph from 9 ft. 9 in.). The only effects from these drops were two small nontender bruises on the right thigh and right groin. The first dirt drop consisted of a side forward, 9 mph drop from 9 ft. 9 in. The medical examinations were negative. The second dirt drop consisted of a feet forward, 16 mph drop from 9 ft. 9 in. The X-ray showed a spinal compression fracture with loss in height of the centrum amounting to about 4 mm. These results indicate that even though the occupant of the B-58 capsule (as well as all presently planned U.S. space vehicles) is positioned to receive backward facing transverse acceleration upon ground impact, the possibility of a spinal injury should be admitted, due to the complexity of the ground impact force. I.v.L.

N63-12866 Frost Engineering Development Corp., Denver, Colo.
THE DYNAMICS OF HUMAN RESTRAINT SYSTEMS
Peter R. Payne *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 195-257 23 refs (See N63-12844 07-16) NAS: $3.00

A program is presented for investigating the basic principles of restraint and the use of dynamic theory to correlate the existing experimental information. A description of dynamic models of the human body is also presented. I.v.L.

N63-12867 Chance Vought Corp. Astronautics Div., Dallas, Tex.
A RESEARCH PROGRAM TO DEVELOP A 60 "G" PERSONNEL RESTRAINT SYSTEM
Howard E. Freeman *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 259-264 3 refs (See N63-12844 07-16) NAS: $3.00

A 60 G personnel restraint system was developed. The central components are an individually fitted, fiber glass, torso garment and a similarly fitted seat pan. These rigid components were selected to provide broad support and preserve the normal body shape under inertial loading. A flexible, low-rebound liner is used for comfort and intimate fit. The torso shell is retained to the seat structure with steel cables to minimize stretching and the resultant rebound. A dacron strap system, positioned by a leather helmet, was chosen to minimize forward head motion. Lateral head supports are mounted on a carriage that adjusts vertically relative to the seat structure for crew-size variation. Low-rebound padding in the helmet cushions the ear area. Arm support is provided by contoured armrests and hand-holds with a strap passed over the crook of the arm holding the arm back and down. The dummy's legs are positioned and restrained by the sides of the seat shell, a central divider, a contoured leg backrest, and a leg cover. Antisubmarine protection for the torso is also provided by the leg cover, which supports the forward inertial loads of the thighs and legs and stabilizes the pelvis by a direct load path through the femur into the pelvic socket. The contoured lower skirt on the torso backshell and the sides of the seat pan reinforce the pelvic socket by limiting lateral shifting of the thighs. The support structure is a tubular steel frame articulated to provide a torso forward position for boost and torso aft position for less stressful flight elements. Full immobilization and restraint are applied in the forward position. I.v.L.

N63-12868 Naval Air Development Center. Aviation Medical Acceleration Lab., Johnsville, Pa.
FULL BODY SUPPORT SYSTEMS
R. F. Gray *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 265-270 3 refs (See N63-12844 07-16) NAS: $3.00

External support systems which are used as protection against acceleration levels that cannot be tolerated by the action of physical mechanisms only, are discussed. Results indicate that while a foam system has weight and safety advantages compared to water, it does not fit the body as well, cannot be used to support regions such as eyes, and a person within it is severely immobilized. Foam castings can give much more complete support than strap systems and can be rapidly formed around or rapidly removed from subjects. Foams seem best applied to one-shot short-term (15 minute) support applications, but some reversible foam casting support systems have been hypothesized. I.v.L.

N63-12869 Frost Engineering Development Corp., Denver, Colo.
AN ANALOG COMPUTER WHICH DETERMINES HUMAN TOLERANCE TO ACCELERATION
Peter R. Payne *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 21-27, 1961 p 271-299 18 refs (See N63-12844 07-16) NAS: $3.00

An analog computer which determines human tolerance to acceleration is discussed. It is indicated that the wide variety of restraint systems in existence demands a wider variety of analog circuits than can be housed conveniently in one package. Examples are: (a) the linear bottoming system with one degree of freedom; (b) two separate linear systems, with different dynamic characteristics in the positive and negative directions; (c) two systems, as in "b", with a substantial "dead zone" around the central position; and (d) truly nonlinear systems for which the simple linear assumption is not adequate. Since many uses will only require the circuit for one of these alternatives, it was decided to manufacture separate "auxiliary computers" for restraint systems, and combine the basic computer to the following seven functions: (1) 88-element acceleration input array; (2) dynamic models of the human body with provision for variable damping; (3) meter readout of the Physiological Index; (4) power supply for both basic and auxiliary computers; (5) "freezing" functions; (6) provision for external injection of the acceleration input signal; and (7) ultrafast read-in, which reduces the time scale to 20 percent of the "normal" value. I.v.L.

N63-12870 Royal Air Force. Inst. of Aviation Medicine, Farnborough (Gt. Brit.)
SOME CURRENT IMPACT STUDIES IN GREAT BRITAIN
J. C. Guignard *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 301-311 2 refs (See N63-12844 07-16) NAS: $3.00

This paper gives a general outline of some of the work which has been done in recent years or is currently in progress in Great Britain in the field of impact acceleration stress. Emphasis is on the work of the Royal Air Force Institute of Aviation Medicine, Farnborough. There is yet no official British-manned spaceflight program. Consequently, there is no work on impact or vibration being done in Government establishments which is specifically related to problems in space medicine. Acceleration research at I.A.M., for example, is directed solely to current problems in service aviation medicine. Author

N63-12871 Air Force Systems Command. Bioastronautics Office, Andrews AFB, Md.
USAF IMPACT ACCELERATION PROGRAM AND FACILITIES
Willard R. Hawkins and Rufus R. Hessberg *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 313-322 (See N63-12844 07-16) NAS: $3.00

The program and its facilities are discussed. The purpose of the program is to establish criteria for design of manned aerospace vehicles in which accelerations, decelerations, buffeting, impact, and pressure differentials are to be encountered during any normal or emergency phase of flight. I.v.L.

N63-12872 Harvard U. Medical School, Boston, Mass.
PATH OF BODY TRAVEL
Alfred L. Moseley *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 323-331 (See N63-12844 07-16) NAS: $3.00
(PHS Grant RG-6084)

General characteristics of the direction of motion of occupants inside vehicles involved in right-angle, rear-end, and fixed-object collisions are described. Three generalizations may be made from sample clinical cases illustrating factors concerned with the path of body travel in the case of sudden deceleration: (1) The design of structures for the purpose of protecting an occupant during deceleration must take into account the location of the impact site. (2) Since multiple impacts occur between vehicles and structures which they hit, deceleration protection must take into account, not only an initial impact, but also the series of impacts which follow between the occupants and the vehicle. (3) Since deaths occur from missiles, a factor which should be of concern in deceleration geometry is the design of enclosures for storage or transportation of equipment, for example the fixation of a tool box in the trunk of an automobile. I.v.L.

N63-12873 General Electric Co. Missile and Space Vehicle Dept., Philadelphia, Pa.

APPLICATION OF THE IMPACT SENSITIVITY METHOD TO ANIMATE STRUCTURES

Murray Kornhauser and Armand Gold *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 333-344 11 refs (See N63-12844 07-16) NAS: $3.00

The impact sensitivity method as applied to animate structures was investigated. This method of correlating and expressing dynamic performance involves what is known as a sensitivity curve. Data are gathered by subjecting identical specimens, in this case mice, to acceleration time pulse of variable duration and amplitude. At each impact duration the minimum level that will cause damage is determined. Results indicated that besides establishing by experimentation that one mammal, the mouse, has an impact tolerance which can be described adequately by the sensitivity curve model, the mouse data also permit broad conclusions when compared with results for other animals. Conclusions may be drawn in regard to individual G-tolerance, effects of differences in species (and size) on tolerance to impulsive velocity changes, and effects of difference in species (and size) on tolerance to long duration accelerations. I.v.L.

N63-12874 Minnesota U., Minneapolis

AUTOMOTIVE HUMAN CRASH STUDIES

James J. Ryan *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p 345-353 6 refs (See N63-12844 07-16) NAS: $3.00

The purpose of automotive human crash studies was to invent and test mechanical designs to reduce the destructive forces of collision on automotive and airspace passengers. Developments which have been produced and tested in this laboratory include engineered automatic seat belts, hydraulic shock absorbing bumpers, a large padded steering post with a short travel absorber and a retracting steering wheel rim for the driver, and a dash recessed under the windshield in front of the passenger. With judicial padding, the flailing of the arms and the legs of the body held by the seat belts are further protected from injuries. I.v.L.

N63-12876 Martin Co., Baltimore, Md.

A CHRONOLOGICAL BIBLIOGRAPHY ON THE BIOLOGICAL EFFECTS OF IMPACT

Carl C. Clark, Denis Faubert, and Bruce Cooper *In* Natl. Acad. of Sci. Impact Acceleration Stress A Symposium held at Brooks AFB, Tex., Nov. 27-29, 1961 p [373]-458 1015 refs (See N63-12844 07-16) NAS: $3.00

A chronological bibliography on the biological effects of impact acceleration is described. A chronological index, an author index, and an organization index is included. I.v.L.

N63-12877 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.

COLD PRESSOR TEST—A 20 YEAR FOLLOWUP STUDY OF 123 SUBJECTS

Margaret F. Allen and David E. Langdon Dec. 1962 9 p 9 refs (SAM-TDR-62-137)

In 1960, blood pressures were obtained on 106 active and retired military subjects on whom the cold pressor test had been performed in 1940. These blood pressures and the cold pressor index (rise in systolic blood pressure, millimeters of mercury) were analyzed for predictability of future hypertension from the index. The mean index of the 11 who became hypertensive was significantly larger than the mean index of the 51, of comparable age, 35 years and older, who remained normotensive. Statistical association was found between hyperreaction (using a cutting point of 10 mm. Hg) and hypertension; however, the accuracy of prediction is not good. Thus the test as defined is not recommended as a predictor of future hypertension. An average increase in diastolic blood pressure of about 7 mm. Hg every 20 years was observed cross-sectionally and longitudinally. Author

N63-12946 California U., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology

SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1962

J. F. Mead et al [1962] 91 p refs
(Contract AT(04-1)GEN-12)
(UCLA 510)

This report covers work being done in the following fields: biochemistry, radiobiology, pharmacology and toxicology, nuclear radiology, medicine, biophysics, and environmental radiation. J.R.C.

N63-13006 Boston U. School of Medicine, Mass.

STUDIES AT MODERATE HYPOTHERMIC TEMPERATURES OF FACTORS AFFECTING SURVIVAL UNDER PROLONGED HYPOTHERMIA [Final] Technical Documentary Report [July 1, 1960-June 30, 1962]

Evangelos T. Angelakos Wright-Patterson AFB, Ohio, Nov. 1962 21 p 8 refs
(Contract AF 33(616)-6767)
(AMRL-TDR-62-130) OTS: $0.75

The purpose of this investigation was to study the mortality of anesthetized dogs maintained under hypothermia for many hours, and to evaluate the factors responsible for death under these conditions. Data are presented on technically successful experiments in 40 dogs maintained at 26° ± 1° C. Among the animals that died during maintained hypothermia, mortality was progressive with no apparent critical time. The median lethal time at 26° ± 1° C is estimated to be 18 hours. There was a progressive decrease in the average normal pacemaker heart rate in animals maintained at a relatively fixed hypothermic temperature. Values of arterial hematocrit showed a progressive and striking increase during cooling, maintained under hypothermia, and rewarming. Neither degree of hypothermic acidosis nor plasma electrolyte changes were altered consistently during maintained hypothermia. The factors limiting survival under prolonged hypothermia are different from those involved in the acute induction of the hypothermic state. Author

N63-13017 Autonetics, Research and Development Div., Downey, Calif.

CORIOLIS EFFECTS ON OPERATOR MOVEMENTS IN ROTATING VEHICLES

Charles P. Greening Feb. 1963 12 p 5 refs

A study is made of the coriolis force on operator movements in rotating spacecraft. The coriolis effects are larger for smaller vehicles and for higher "g" systems. The coriolis effects decrease more slowly than do "g" forces when the vehicle spin rate is decreased. The negative effect of coriolis forces in rotating spacecraft can be minimized by: (1) arranging work areas so that as many operator motions as possible lie in the least disturbing direction; (2) arranging work loads and equipment layouts to minimize requirements for rapid movements over large distances or for frequent or rapid changes in head or body orientation; (3) using large-radius vehicles (with consequent low spin rates); and (4) minimizing the mass of protective devices, especially those on the extremities, to be worn by operators. J.R.C.

N63-13073 California U., Berkeley. Lawrence Radiation Lab.

CLOSED ECOLOGICAL LIFE-SUPPORT UNIT FOR PRIMATES

Mitchell Sabanas Dec. 10, 1962 24 p
(Contract W-7405-eng-48)
(UCRL-10589) OTS: $0.50

A closed ecological life-support unit was fabricated. Design and construction details of this unit are presented together with photographs and graphical illustrations. The arrangement is ground-based and is designed to serve as a research tool for physiological studies. The unit consists of a hermetically sealed cabin, regenerable air-purification means, and water and food dispensers. The combination of silica gel and molecular sieve constitutes a regenerable adsorption system for removal of carbon dioxide and moisture. The system described maintains a primate unrestricted and controls its life-support system automatically. The feeding system is sealed into the cabin with a provision to deliver and control the quantity of food and water for the enclosed primate. For convenience of storage and disposal, the food is packed in gelatine capsules. Capsules are placed on conventional sticky masking tape and rolled into a reel. A specially designed dispensing unit delivers a food capsule to the primate at preset time intervals. Functioning principles of the feeder can be utilized under zero-gravity conditions. Results of a 25-day test run are reported. A cardiac-pressure simulator is described and illustrated. Author

N63-13079 Naval Radiological Defense Lab., San Francisco, Calif.
RADIOSENSITIVITY OF BIOELECTRIC FUNCTIONS OF RAT STOMACH AND CAECUM
B. E. Vaughan and A. K. Davis Jan. 8, 1963 28 p 24 refs
(USNRDL-TR-611)

Experimental studies of electrolyte absorption in the gastro-intestinal tract have here established the existence of both delayed and immediate irradiation effects, as measured by bioelectric energy production in excised stomach and caecum tissues maintained *in vitro*. The delayed effects are dose dependent and show a neutron RBE of 2.7 compared to X-rays. Both effects are produced indirectly, and the gastric reduction in bioelectric power requires irradiation change in both the secretory epithelium and parasympathetic nerves. Hence, the differential radiosensitivity of stomach and caecum must be determined by indirect factors, undoubtedly biochemical, rather than by differences inherent in the composition of each tissue by itself. Author

N63-13142 Boeing Co. Aero-Space Div., Seattle, Wash.
INVESTIGATION OF SELECTED HIGHER PLANTS AS GAS EXCHANGE MECHANISMS FOR CLOSED ECOLOGICAL SYSTEMS [Final Report] Covering Period March 1961 to April 1962
A. E. Prince, A. J. Pilgrim and S. P. Johnson Wright-Patterson AFB, Ohio, Biomedical Lab., Sept. 1962 88 p 18 refs
(Contract AF 33(616)-7945)
(AMRL-TDR-62-127) OTS: $2.25

The growth of a variety of Angiosperms was evaluated under controlled conditions in low intensity fluorescent light. Although a large number of species exhibited various abnormalities, three species, *Brassica Chinesis, Chichorium endiva, Amaranthus gangeticus,* were able to tolerate and grow normally under the conditions used. Studies of the photosynthetic activity of these plants showed that a great deal of variation is to be expected both under standard conditions of culture and in media containing increased salt concentrations. Studies of photosynthetic activity by the plants in an atmosphere with the nitrogen replaced with argon or helium indicated that these gases had no adverse effects. Analysis of the three plants included estimation of amino acids, carbon, water and alcohol soluble carbohydrates, protein, nitrogen, ash, lipid, and vitamins A, C, and E. The results indicate that the roots, stems, and leaves of these three species could provide a valuable nutritional supplement. Feeding of the plants to rabbits demonstrated that no acutely toxic compounds are present. Author

N63-13143 Chance Vought Corp. Astronautics Div., Dallas, Tex.
INVESTIGATION OF A PERSONNEL RESTRAINT SYSTEM FOR ADVANCED MANNED FLIGHT VEHICLES Technical Documentary Report [May 1960-Feb. 1962]
Howard E. Freeman, William C. Boyce, and C. F. Gell Wright-Patterson AFB, Ohio, Life Support Systems Lab., Dec. 1962 152 p 121 refs
(Contract AF 33(600)-41418)
(AMRL-TDR-62-128) OTS: $3.00

To develop new concepts for personnel restraint, the following studies were conducted. Characteristic accelerations were defined for advanced manned flight systems. Accelerations of 8G to 12G which are associated with ballistic reentry, produce the most severe physiological stress. Landing impact, generating low-total-energy accelerations of 60- to 100-G's peak on the capsule, produced the most severe structural loading. Human tolerance to acceleration was studied by a survey of the available test data and a structural analysis of the human body. Test data for high-peak-magnitude low-total-energy acceleration exposures were not reported in the literature on controlled experimentation. Case histories of accidental falls and suicides were studied to gain insight into human tolerance to this type of acceleration. Several basic crew restraint concepts were evolved and evaluated. A concept employing rigid contoured support was selected to limit body-element displacement and distortion and to minimize rebound. A test system was designed and fabricated. Mechanisms were designed to pre-position and pre-tension the crewman mechanically prior to impact. Further research should include thorough testing of the test system to determine the protection achieved by rigid contoured restraint. If high level protection is demonstrated, an operational prototype should be developed. Author

N63-13145 AiResearch Mfg. Co., Los Angeles
SUBCRITICAL LIQUID OXYGEN STORAGE AND CONVERSION SYSTEM FOR OMNIGRAVIC OPERATION [Final] Report
R. L. Polk Wright-Patterson AFB, Ohio, Life Support Systems Lab., Dec. 1962 24 p
(Contract AF 33(616)-7153)
(Engineering Rept. AE-2072-R; AMRL-TDR-62-143) OTS: $0.75

This program was directed toward the design and development of a low-pressure storage system for the storage of liquid oxygen, the conversion of the liquid to usable, gaseous state, and the controlled delivery of the gaseous oxygen under omnigravic conditions. The program was an extension of the feasibility study of a system employing an internal relief valve, and provided for, in particular, the minimization of evaporation loss of stored liquid oxygen through standby venting caused by heat leakage to the stored liquid, and the development of suitable fluid capacity gaging equipment. This report presents an account of the design and development of a subcritical liquid oxygen storage and conversion system and outlines the final engineering conclusions and recommendations. Author

N63-13178 Armour Research Foundation, Chicago, Ill.
PHYSICAL AND CHEMICAL CHARACTERISTICS OF CHLOROPLAST FRAGMENTS. APPLIED RESEARCH CONCERNING ARTIFICIAL PHOTOSYNTHESIS Technical Documentary Report [1 Nov. 1961-14 Sept. 1962]
Jean A. Gross, Milton J. Becker, and Alan M. Shefner Wright-Patterson AFB, Ohio, Biomedical Lab., Dec. 1962 51 p 36 refs
(Contract AF 33(616)-7255)
(AMRL-TDR-62-146)

Chloroplasts isolated from spinach leaves were physically fragmented and then fractionated by differential centrifugation. A high-activity fraction, designated CF_{20-50}, was obtained and retained its high activity regardless of environmental changes. It had a low protein content and a relatively high chlorophyll-to-protein ratio. Plastoquinone was present in high concentration. Extraction of plastoquinone from CF_{20-50} inhibited Hill activity. Unlike whole chloroplasts, readdition of plastoquinone failed to induce even partial recovery. The average particle size in CF_{20-50} was 1500 A diameter. The average particle size in CF_{20-50} was 1500 A diameter. The average sedimentation constant was 800; the molecular weight was about

8×10^7; and it showed three electrophoretic bands. The CF_{20-50} unit studied. Although the nature of the smallest functional unit is uncertain, it is clear that a CF_{20-50} particle is composed of smaller subunits probably oriented to impart high activity to the larger composite structure. Author

N63-13206 Naval Radiological Defense Lab., San Francisco, Calif.
EFFECTS OF DIVIDED DOSES OF X-RAY ON MORTALITY AND HEMATOLOGY OF SMALL AND LARGE DOMESTIC ANIMALS
G. F. Leong, W. G. Wisecup, and J. W. Grisham Jan. 7, 1963 22 p 17 refs
(USNRDL-TR-606)

An attempt to establish a correlation of systemic recovery with hematological recovery after X-radiation exposure for the mouse, rabbit, sheep, and goat under uniform experimental conditions is presented. This is part of a continuing program being conducted in this Laboratory in an effort to provide a valid estimate of the rate of recovery in man after radiation exposure by these correlative factors for various species.

By separating these animals into two broad groups, small and large animals, significant differences have been demonstrated as to their LD 50/30, hematological recovery, and systemic recovery. Furthermore, a significant departure from the generally accepted exponential recovery after a radiation insult has been shown for both small and large animals. The need for a more critical analysis of recovery at intervals well past the recovery half-time is indicated in evaluating rates of recovery. Author

N63-13222 National Aeronautics and Space Administration, Washington, D.C.
POSTURAL REFLEXES IN INTACT ANIMALS UNDER CONDITIONS OF WEIGHTLESSNESS
V. I. Yazdovskiy, E. M. Yuganov, and I. I. Kas'yan (Acad. of Sci., USSR) Mar. 1963 9 p 11 refs Transl. by Scripta Technica, Inc. of "Ustanovichnyy refleks intaktnykh zhivotnykh v usloviyakh nevesomosti" from Izv. Akad. Nauk SSSR, Ser. Biol. (Moscow), no. 5, 1960 p 762-767
(NASA TT F-130) OTS: $0.50

Experiments were conducted on two albino rats and two albino mice to study their postural reflexes under conditions of alternately increased and decreased gravity and to determine the time required for development of adaptive reactions in the weightless state.
Author

N63-13223 National Aeronautics and Space Administration, Washington, D.C.
MUSCLE TONUS UNDER CONDITIONS OF WEIGHTLESSNESS (O MYSHECHNOM TONUSE V USLOVIYAKH NEVESOMOSTI)
E. M. Yuganov, I. I. Kas'yan, and V. I. Yazdovskiy Mar. 1963 10 p 5 refs Transl. by Scripta Technica, Inc. from Izv. Akad. Nauk SSSR, Ser. Biol. (Moscow) no. 4, 1960 p 601-606
(NASA TT F-131) OTS: $0.50

An experiment was carried out to study the nature and degree of change in tonus of a rabbit's eye muscles under conditions of the intermittent action of increased gravity and weightlessness. Author

N63-13268 General Mills Electronics Group, Minneapolis, Minn.
RESEARCH TO DETERMINE THE EXISTENCE AND IDENTITY OF VIABLE MICROORGANISMS IN THE STRATOSPHERE Final Technical Report, January 1-December 31, 1962
V. W. Greene Dec. 31, 1962 58 p 13 refs
(NASA Contract NASr-81)
(Rept. 2363) OTS: $5.60 ph, $1.94 mf

During 1962, several autoclavable large-volume air samplers, suitable for collecting microbial contaminants from the stratosphere, were constructed. Two successful balloon-borne probes were carried to 65,000 and 90,000 ft, respectively, and large volumes of ambient air were taken from specific stratospheric profiles during controlled descents. During the first probe (August 1, 1962), 21,000 colonies were recovered from the 60,000- to 45,000-ft profile (0.3 per ft^3); 490 colonies from the 45,000- to 30,000-ft profile (0.06 per ft^3); and 112 colonies from the 30,000- to 10,000-ft profile (0.016 per ft^3). The high-altitude sample yielded several types of yeasts—*Cladosporium sp* and *Alternaria sp* molds; and members of three pigmented bacterial genera—*Flavobacterium sp*, *Brevibacterium sp* and *Corynebacterium sp*. The organisms isolated from the middle and low altitude profiles were prodominantly *Penicillium sp*. During the second probe (October 19, 1962), 128 colonies were recovered from 90,000- to 60,000-ft profile (0.0009 per ft^3) and approximately 200 colonies from the 60,000- to 40,000-ft profile (0.01 per ft^3). This level of contamination was not significantly greater than that encountered on the "sterility" controls. The apparent discrepancy between the two flights may possibly be related to meteorological parameters. Author

N63-13315 Air Force Hospital, Lackland AFB, Tex.
AEROMEDICAL REVIEWS. CARDIOPULMONARY RESUSCITATION. PT. I: EVALUATION OF TEACHING PROGRAM. PT. II: DIDACTIC PRESENTATION OF PROGRAM
Richard C. Wolff and Richard J. Ward Brooks AFB, Tex., USAF School of Aerospace Medicine, Jan. 1963 34 p 62 refs
(*Its* Review 10-62)

A course in cardiopulmonary resuscitation is outlined and explained. An evaluation of the teaching program is presented. I.v.L.

N63-13325 Federal Aviation Agency. Civil Aeromedical Research Inst., Oklahoma City, Okla.
AN IMPROVED METHOD FOR DETERMINING THE EFFICIENCY OF CREW AND PASSENGER OXYGEN MASKS A Preliminary Report
Ernest B. Mc Fadden, James W. Raeke, and Joseph W. Young Nov. 1962 18 p 2 refs
(CARI-62-21)

A method of determining oxygen mask leakage was evaluated. Measurement of nitrogen concentration within an oxygen mask following respiratory nitrogen washout appears to provide a valid index of inboard mask leakage. Further development of this technique and its application to a proposed mask design is described.
Author

17 MACHINE ELEMENTS AND PROCESSES

Includes: bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling, and inspection.

For related information see: 06 Auxiliary Systems.

N63-12903 Naval Research Lab., Washington, D.C.
REPORT ON SPECIAL MEETING TO DISCUSS NONDESTRUCTIVE TESTS FOR FILAMENT WOUND FIBERGLASS MOTOR CASES AT AEROJET-GENERAL CORPORATION ON JAN. 24-25, 1963
Stephen D. Hart [1963] 7 p
(NRL Memo-221)

The meeting on nondestructive testing is covered: hydrotesting; sonic, X-ray, and microwave inspection; and radiography. It is recommended that a quick scan technique be developed that can cover the whole motor, including insulator, and that can detect debonds and delaminations. R.C.M.

N63-12938 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.

SEGMENTED ROCKET MOTOR CASE PROGRAM Quarterly Progress Report No. 3, 15 Oct. 1962-15 Jan. 1963

R. G. Carpenter and T. R. Jeffus Jan. 15, 1963 59 p 6 refs
(Contract AF 04(611)-8184)
(SM-42911)

This program is directed toward design, development, fabrication, and testing of lightweight motor case segments, culminating in a design applicable to large (160- to 240-in. diameter) segmented solid-propellant rocket motors. A summary of work accomplished on the bench test program and on the 43-in.-dia. subscale segments is included. Douglas-funded programs related to the segmented booster program are discussed. Tests completed during the current report period are described. Author

N63-12947 Hanford Atomic Products Operation, Richland, Wash.

EVALUATION OF PROPERTIES OF IRRADIATED ZIRCALOY-2 PRESSURE TUBE FROM KER LOOP 1

L. J. Defferding Dec. 1962 23 p 5 refs
(Contract AT(45-1)-1350)
(HW-67949 REV) OTS: $0.50

A destructive examination was conducted to determine the effect of the total KER (Hanford Production Reactor) environment on the burst properties and the grain structure of the Zircaloy-2 pressure tube from KER Loop-1. After irradiation, the lower portion of the inner surface of the tube was covered with a reddish film. Spectrographic analysis of the film showed that it consisted primarily of iron oxide. No evidence of hydrogen pickup was found after examining four samples of complete rings from evenly spaced locations along the entire length of the tube. The room-temperature burst-strength averaged 127,000-psi loop-strength for four normal samples as compared to an unirradiated loop-strength of 108,000 psi. The tube was capable of withstanding the operating pressure and temperature of the loop, but was damaged with an impact loading during cutting. J.R.C.

N63-13077 Republic Aviation Corp. Mfg. Research Dept., Farmingdale, N. Y.

DETERMINATION OF CAUSES OF CRACKING IN WELDING AGE HARDENABLE HIGH TEMPERATURE ALLOYS [Final Report, 1 Nov. 1960-1 Nov. 1961]

B. S. Blum Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Apr. 1962 238 p 121 refs
(Contract AF 33(616)-7670)
(Mfg. Res. Dept. Rept. 60-126; RAC-509; ASD-TR-61-678)

Tensile, hot ductility, metallographic and weldability studies were conducted to determine the cause of base metal cracking in A-286 weldments. A mechanism for cracking was proposed, based on grain size, interstice formation by grain boundary sliding or Fe_2 Ti-Fe liquation, embrittlement by Ni_3 (Al, Ti) general and TiC grain boundary precipitation on insufficiently rapid cooling. The effect of stress on weld metal cracking was studied with variable restraint specimens, and optimum filler wires were evaluated on segmented finger specimens. The strain-age cracking study conducted on Rene' 41 and Inconel X concentrated on the nonequilibrium time between the annealed condition and the aged condition in the 1050° F to 1500° F temperature range. Tensile and dilatometric studies indicated a possible transient embrittlement on initial heating. The time, temperature, and prior material history dependence of the aging contraction was studied; and based on these results, and on a metallographic analysis of Inconel X, a mechanism to account for strain-age cracking was developed. The difficulties encountered in developing a valid strainage cracking specimen are discussed. Author

N63-13086 Mechanical Technology, Inc., Latham, N. Y.

EXPERIMENTAL INVESTIGATION OF TWO-PHASE FLOW IN THRUST BEARINGS

F. K. Orcutt Jan. 1963 38 p 2 refs
(Contract Nonr-3731(00)(FBM))
(MTI-62TR40)

An analytical study is made of two-phase flow in thrust bearings. For all the operating conditions investigated, there is a sharply defined load-carrying limitation for the steam-lubricated bearing beyond which there is a sudden loss of stiffness leading to collapse of the bearing and contact of the surface. Bearing-load carrying capacity and stiffness are strongly dependent on the rate at which heat is withdrawn from the film by the bearing surfaces. Condensate in the form of droplets and streaks forms on the uncooled surface near the outer radius as the load approaches the critical load for collapse of the bearing. The performance of the experimental bearing lubricated with steam is compared with its theoretical performance using a single-phase lubricant having the properties of dry steam. Results indicate that, for a fixed inlet pressure and surface separation, a two-phase bearing has considerably lower carrying capacity. For the bearing configuration used there was very little dependence of bearing performance on rotor speed. Instability was observed occasionally when the shaft was stationary and conditions at onset were such that the bearing was close to the verge of collapse. J.R.C.

N63-13093 Pennsalt Chemicals Corp. Research and Development Dept., Wyndmoor, Pa.

RESEARCH ON THE COMPATIBILITY OF WELDED STRUCTURAL MATERIALS WITH CHLORINE TRIFLUORIDE, PERCHLORYL FLUORIDE AND MIXTURE OF THESE Third Quarterly Progress Report [Oct. 1-Dec. 31, 1962]

John C. Grigger and Henry C. Miller Jan. 15, 1963 45 p 1 ref
(Contract AF 33(657)-8461)

Fabrication, including heat treatment and cleaning, of all welded metal specimens, both tensile and stress form, required for the static immersion tests has been completed. Mechanical properties (T.S., Y.S., and % elong.) have been determined for four replicate welded tensile specimens of each of the nine alloys after heat treatment, to serve as control values. Thermostated safety-cell facilities in a high pressure laboratory were assembled and tested for the one-year, 30° C immersion tests. Three oxidizers and 540 tensile and stress specimens were loaded into 36 steel pressure tanks to begin these one-year exposures. This test phase provides for liquid, vapor, and interface exposures to chlorine trifluoride, perchloryl fluoride and a 25% ClO_2F - 75% ClF_3 mixtures. The 21-day, 30° C immersion tests have been started in a second safety-cell facility containing 12 pressure tanks. Planning and assembling of equipment and specimens for the dynamic exposure tests have begun. Author

N63-13117 Rock Island Arsenal Lab., Ill.

ENZYMATIC DEOXYGENATION. A NEW CONCEPT IN CORROSION PREVENTION Technical Report No. 2

W. F. Garland Oct. 17, 1962 34 p 20 refs
(RIA-62-3441) OTS: $1.00

In an effort to improve the prototype deoxygenating packet, an investigation was initiated into increasing the rate of reaction and shelf life. Three surfactants were evaluated in a saturated buffered glucose solution with a view toward increasing its absorption on the molecular sieves, and the capacity and rate of oxygen absorption of the deoxygenating medium. Surfactant A proved to be the most effective wetting agent used, increasing both the capacity and

rate of the original mixture. Four forms of molecular sieves (1/16 in, 1/8 in, powdered, and "improved") a second synthetic zeolite and activated alumina were investigated as substrate material for the deoxygenating liquid. Of the several materials tested, activated alumina provided the best balance of substrate properties, inert, highly absorbant, and inexpensive. An improved deoxygenating packet utilizing activated alumina as the substrate material for the deoxygenating liquid is described. Author

N63-13118 Rock Island Arsenal Lab., Ill.
TRANSPARENT SKIN AND BLISTER PACKAGING Technical Report
R. L. Murrens Oct. 31, 1962 26 p
(RIA-62-3600) OTS: $0.75

Transparent skin and blister packages enclosing steel panels and various small items were fabricated by vacuum forming and electronic sealing equipment and submitted to various laboratory accelerated tests for evaluation. The results of these tests indicated that a polyester-polyethylene laminate as a skin packaging material would provide level A protection. Both vinyl and cellulose acetate butyrate have excellent clarity and qualities for fabrication with automatic vacuum forming and electronic sealing equipment. These materials have limited use. When formed into blisters and subjected to low temperature and high humidity tests, the blisters exhibited embrittlement, cracking, and swelling. Author

N63-13138 Calorobic Material, Inc., Pearl River, N.Y.
DEVELOPMENT AND UTILIZATION OF OPTIMUM TECHNIQUES FOR THE FABRICATION OF TITANIUM BORONITRIDE ROCKET NOZZLES First Quarterly Report for the Period July 1-Sept. 1, 1962
R. Strickman and J. Donnellon Oct. 1962 17 p
(Contract DA-30-069-ORD-3747)
(TR 371-9/4)

This report summarizes the work completed on the preparation and initial development techniques for the fabrication of titanium diboride-titanium nitride-boron nitride rocket nozzle inserts and other test specimens. Design of machinery, equipment, and tooling required to produce the various parts has been initiated. In the fabrication of test parts, the need of new machining techniques and nondestructive parts inspection before and after machining was evident. Author

N63-13172 Springfield Armory, Mass.
INVESTIGATION OF PACKAGING METHODS AND SUB-METHODS WITH VOLATILE-CORROSION-INHIBITOR TREATED MATERIALS
Gerald Pributsky Aug. 1, 1962 41 p
(SA-TR20-2313) OTS: $1.25

An investigation was made to evaluate the suitability of using various submethods with volatile-corrosion-inhibitor-treated materials in the packaging of small arms components. Packages were stored under two conditions: (1) in an outdoor shed to simulate minimum warehouse storage and (2) in a static humidity cabinet to simulate tropic storage. Heat-sealable polyester film with volatile-corrosion-inhibitor innerwrap provided satisfactory protection in the humidity cabinet for one year. Results of this investigation indicate that packaging submethods other than those specified in MIL-I-8574 can be satisfactorily used with VCI preservatives. Test procedures are described and results given. Author

N63-13263 Hughes Aircraft Co., Culver City, Calif.
DEVELOPMENT OF REFRACTORY FABRICS Quarterly Report No. 6, 3 June 1962 to 2 September 1962
L. E. Gates and W. E. Lent Sept. 15, 1962 28 p 4 refs
(NASA Contract NAS8-50)
OTS: $2.60 ph, $1.04 mf

Continued studies of a refractory glass melting furnace, including an electrical temperature boost system, are described. The efficiencies of several fiberizing nozzle configurations have been determined. Carding and spinning studies of ceramic fibers are described. A method is discussed for establishing conditions for evaluating ceramic fabrics under a dynamic hyperthermal environment. Author

N63-13288 Hughes Aircraft Co. Components and Materials Lab., Culver City, Calif.
DEVELOPMENT OF REFRACTORY FABRICS Quarterly Report No. 4, 3 December 1961 to 2 March 1962
L. E. Gates and W. E. Lent Mar. 15, 1962 17 p 2 refs
(NASA Contract NAS8-50)
OTS: $1.60 ph, $0.80 mf

Operating principles are described for a high temperature furnace to supply a molten glass stream for fiberizing by blowing. Preliminary experiments involving heating of glass by oxygen-acetylene flames and an electric current are discussed. The effects of insulation geometry on furnace construction are given. An introduction to the problem of carding brittle ceramic fibers is included with a description of a proposed carding apparatus. A testing apparatus is described for subjecting refractory fabric specimens simultaneously to high heat fluxes and dynamic mechanical stresses. Author

N63-13289 Hughes Aircraft Co. Components and Materials Lab., Culver City, Calif.
DEVELOPMENT OF REFRACTORY FABRICS Quarterly Report No. 5, 3 March 1962 to 2 June 1962
L. E. Gates and W. E. Lent June 15, 1962 20 p
(NASA Contract NAS8-50)
OTS: $1.60 ph, $0.80 mf

The development of the construction and the operating procedures of two refractory glass melting furnaces are discussed. The principles of the formation of a continuous refractory glass stream suitable for fiberizing are considered. Further improvements in the furnaces are suggested. One commercial ceramic fiber has been selected as the best choice for studying new carding principles for brittle fibers. Author

18 MATERIALS, METALLIC

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Non-metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-12904 Aerospace Corp., El Segundo, Calif.
TRENDS AND FUTURE DEVELOPMENTS IN AEROSPACE MATERIALS
Leo E. Gatzek and James L. H. Peck Dec. 15, 1961 45 p 22 refs
Presented at the Symposium on Ballistic Missile and Aerospace Technology, U. of Southern Calif., Aug. 1961
(Contract AF 04(647)-930)
(TDR-930(2411)TN-1)

A survey is given of the current state of the materials art and certain developmental trends indicated for the period to 1970. Stresses and skin temperatures of manned vehicles can be expected to increase as vehicle operations evolve kinetically from Mercury orbital

missions through Dyna Soar boost-glide reentry and eventual lunar reentry. A general evaluation of promising new materials includes superalloys such as Nicrotung, René 41, Udimet 700 and Inco 717C. Projected improvements for refractory metals are examined, together with brief discussions of composites, plastics, foams, metal fabrics, filament-wound structures, and the use of metals as fuels. Coatings, elastomers, and adhesives are discussed. Attention is also directed toward the cryogenic behavior of both metals and nonmetals. Author

N63-12926 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

OBSERVATIONS OF PROPERTIES OF SINTERED WROUGHT TUNGSTEN SHEET AT VERY HIGH TEMPERATURES

E. C. Sutherland and William D. Klopp Washington, NASA, Feb. 1963 41 p 9 refs

(NASA TN D-1310) OTS: $1.00

The mechanical properties of five typical lots of commercial tungsten sheet were examined at temperatures from 3650° to 5200° F. The ductile-to-brittle transition temperature in bending was also determined. Results showed that the properties varied widely with the material lot. The greatest variation in mechanical properties occurred at maximum temperatures. Trace elements and grain size appear to affect high-temperature properties and the transition temperature significantly. Author

N63-12944 Rocketdyne, Canoga Park, Calif.

ADVANCED TECHNOLOGY FOR PROPULSION SYSTEMS. VOLUME III: REFRACTORY MATERIALS Final Report

J. W. Robinson Dec. 15, 1961 146 p

(Contract NOw 60-0445-c)

(R-3350-3)

This report encompasses a general discussion of refractory materials in relation to design and analysis of advanced rocket motor components. The absence of numerous material properties emphasizes the necessity of intensive material research before these materials can be applied efficiently to particular designs. Author

N63-12993 Los Alamos Scientific Lab., N. Mex.

COMPATIBILITY OF THE MAJOR ELEMENTAL COMPONENTS OF TYPE 302-B STAINLESS STEEL WITH PuO_2 AND UO_2

W. C. Pritchard, K. A. Johnson, and J. A. Leary Feb. 6, 1963 34 p 4 refs

(Contract W-7405-eng-36)

(LA-2828)

The compatibility of Fe, Cr, Ni, Si and types 302 and 302-B stainless steel powders with PuO_2 powder in sintered compacts was studied. The composition of the compacts was 50 v/o PuO_2. The powders were mixed and cold compressed at 50 tsi, and the resulting pellets were sintered in argon at 1325° or 1425° C for times between 2 and 28 hr. The pellets were examined metallographically and their densities were determined. It was found that under the test conditions, Si and type 302-B stainless steel, but not Ni and type 302 stainless steel, reacted with PuO_2. The results for Cr and Fe were less conclusive. The compatibility of 302-B stainless steel and Si powders with UO_2 powder was also studied. It was found that UO_2 reacted with Si but not with the stainless steel. Author

N63-12998 Battelle Memorial Inst., Columbus, Ohio

EFFECTS OF LARGE NEUTRON DOSES AND ELEVATED TEMPERATURE ON TYPE 347 STAINLESS

William E. Murr, Frederic R. Shober, Robert Lieberman, and Ronald F. Dickerson Jan. 21, 1963 54 p 9 refs

(Contract W-7405-eng-92)

(BMI-1609) OTS: $1.25

Tests of subsize tensile and impact specimens of AISI Type 347 stainless steel irradiated in three capsules to fast-neutron exposures of up to 1.1×10^{22} nvt were conducted as part of a continuing eleven-capsule irradiation program involving 144 specimens of this material and fast-neutron exposures from 5×10^{21} to greater than 3×10^{22} nvt. Ductile fractures at impact energies of 65 ft-lb, representing a 35 percent decrease in impact strength, were noted at room temperature. Impact energies of only about 20 ft-lb and a fracture with both brittle and ductile characteristics were observed at -300° F. Irradiation-induced property changes included increases in yield strength from 35,000 to 105,000 psi and in ultimate strength from 90,000 to 112,000 psi and a decrease in total elongation from 63 to 31 percent at room temperature. Somewhat lesser changes were noted in specimens tested at 600° F. A 600° F anneal produced no measurable recovery of preirradiation properties (based upon hardness measurements) for periods up to 144 hr. A large degree of recovery was obtained by annealing 1 hr at 1800° F. Mechanical-property data were also obtained from Type 347 stainless specimens machined from sections of the ETR J-10 pressure loop after fast-flux exposures of up to 7.1×10^{21} nvt. Surprisingly, in material irradiated at 750° F, increases in ultimate strength from 92,000 to 149,000 psi and in yield strength from 55,000 to 149,000 psi (60 and 100 percent, respectively) and decreases in elongation from 55 to 10 percent and in reductions in area from 70 to 60 percent were found. Additional tests made at 750° F showed greater reductions in ductility. Somewhat smaller effects were noted for specimens irradiated at ambient reactor temperatures. Problems associated with nickel dosimetry for fast-flux determinations in the study led to the use of the $Fe^{54}(n,p)Mn^{54}$ reaction to establish exposures. Author

N63-13052 California U., Los Angeles

THE EFFECT OF THE ELASTIC INTERACTION ON THE RATE OF CLUSTER GROWTH

George Sines, William Grupen, and Ryoichi Kikuchi Nov. 1962 69 p 15 refs

(Contracts DA-ORD-31-124-61-687 and DA-04-495-ORD-1250)

(Rept. 62-32; AROD-2064-4)

When point defects, such as foreign atoms, atoms displaced from their equilibrium sites, or vacant lattice sites, are present in a metal in sufficiently supersaturated concentrations, clusters of these defects are formed. The migration of additional defects toward these clusters may be biased by long-range interactions with the clusters. The principal long-range interaction is the elastic one caused by the distortions of the parent lattice by the cluster and the point defect. The purpose of this study is to examine the effect of this elastic interaction on the rate of cluster growth. In the analyses, the concentration of the point defects is assumed to be low enough to make the effect of changes in concentration on diffusivity negligible. It is also assumed that the diffusivity is not affected by the stress field. Although the concentration of defects is assumed to be low in this respect, it is also assumed to be supersaturated to the extent that when a point defect attaches itself to a cluster there is a negligible probability of its leaving. The diffusivity and the elastic constants for the medium are assumed to be isotropic. Author

N63-13054 Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

THE FLOW AND FRACTURE OF ZONE REFINED TUNGSTEN Quarterly Progress Report, June 21, 1962 to Sept. 30, 1962

David Benjamin and Marvin Herman [1962] 18 p 30 refs

(Contract DA-36-ORD-3747RD)

(Q-B1973-1; WAL-TR-834.2/11)

A discussion of the brittle ductile transition and the deformation modes of tungsten is presented. The application of the electron-beam techniques for purifying tungsten is compared to the induction-melting technique. The construction details of an induction-type zone melter is presented. Author

N63-13065 Agronne National Lab., Ill.

THERMAL EXPANSION OF ALPHA-ZIRCONIUM SINGLE CRYSTALS

Lowell T. Lloyd Jan. 1963 43 p 9 refs
(Contract W-31-109-eng-38)
(ANL-6591)

Single crystals of alpha zirconium have been used to measure, between room temperature and 860° C, the thermal expansions in the two principal crystallographic directions of the hexagonal-close-packed structure. The measurements were made with a dilatation interferometer. Equations which represent the lengths along the a and c axes and volume as functions of temperature are as follows:

$L_t°C(\perp \text{ to c axis}) = L_0°C(1 + 5.145 \times 10^{-6}t)$;

$L_t°C(\parallel \text{ to c axis}) = L_0°C(1 + 9.213 \times 10^{-6}t - 6.385 \times 10^{-9}t^2 + 18.491 \times 10^{-12}t^3 - 9.856 \times 10^{-15}t^4)$;

$V_t°C = V_0°C(1 + 19.756 \times 10^{-6}t - 7.023 \times 10^{-9}t^2 + 19.146 \times 10^{-12}t^3 - 9.890 \times 10^{-15}t^4)$.

These results do not differ greatly from previous thermal expansion data which were obtained by measurements of the lattice constants at different temperatures. But the dilatation data are for the entire temperature range, whereas the lattice-constant data were for two different ranges. The dilatation data indicate that the lattice constants at the higher temperature were subject to error because of contamination by gaseous impurities. Author

N63-13066 Argonne National Lab., Ill.

INVESTIGATIONS IN THE SYSTEM URANIA-NEODYMIA

D. Kolar, J. H. Handwerk, and R. J. Beals Dec. 1962 26 p 13 refs
(Contract W-31-109-eng-38)
(ANL-6631)

Urania-neodymia compositions were sintered in air and in hydrogen. The compositions were studied by chemical, X-ray, and differential thermal analyses. Solid solutions formed readily in air-sintered compositions in the range from 20 to 60 m/o Nd_2O_3. Solid solutions formed slowly and incompletely, up to 1650° C, in hydrogen-sintered compositions. There was good correlation between the differential thermal analyses and the chemical and X-ray analyses. Author

N63-13128 New York U. Coll. of Engineering, N.Y.

DEVELOPMENT OF TOUGH, HIGH STRENGTH ALPHA-BETA TITANIUM-BASE ALLOYS AT 240,000-260,000 PSI YIELD STRENGTH LEVEL Quarterly Progress Report No. 1, June 25-Sept. 25, 1962

P. A. Farrar and H. Margolin [1962] 11 p 5 refs
(Contract DA-30-069-ORD-3690)
(WAL TR 401/303)

To develop titanium alloys with 0.1% yield strength in the range 240,000 to 260,000 psi, a series of 15 eight-pound alloys are being prepared at two interstitial levels. Following their evaluation, 4 fifty-pound alloys will be prepared and tested both as sheet and bar stock. Weldability studies will be performed on the sheet material. Melting of the eight-pound ingots is in progress, and beta transus temperatures have been determined for all the composition on 25-g buttons. Author

N63-13141 Williams (Clyde) and Co., Columbus, Ohio

CELLULAR METAL—AN INTRIGUING MATERIALS CONCEPT

Washington, OTS [1962] 23 p 20 refs
(Contract CC-4569)
OTS: $0.50

Methods of producing cellular metals, and their characteristics and applications are reviewed. I.v.L.

N63-13166 Bureau of Mines. Minneapolis Metallurgy Research Center, Minn.

EXPERIMENTS IN USING AN ELECTROCHEMICAL CELL TO ANALYZE HIGH-PURITY IRON

H. W. Kilau and J. P. Hansen 1963 15 p 7 refs
(BM-RI-6183)

Thermodynamic calculations indicate that an electrochemical cell might serve as an analytical device for determining the composition of high-purity metals. An equation, readily derived, for the cell voltage, E, is as follows:

$$E = \left(\frac{-RT}{nF}\right) \ln \left[\frac{N_{Fe\ \text{unknown sample}}}{N_{Fe\ \text{standard}}}\right]$$

The cell, however, must come to equilibrium, must be reversible, and must have no thermal effects or complicating side reactions whose magnitude is indeterminable. This Bureau of Mines investigation explores the feasibility of an electrochemical technique for the analysis of high-purity iron. Experiments were conducted using room-temperature aqueous cells and high-temperature molten salt cells. The room-temperature cells proved to be irreversible. The high-temperature cells utilizing $FeCl_2$ and a eutectic mixture of KCl-LiCl were reversible, but did not attain a constant voltage necessary for analytical considerations. Author

N63-13175 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

ALLOYS BASED ON HIGH-MELTING COMPOUNDS

C. V. Samsonov and K. I. Portnoy July 24, 1962 391 p 316 refs
Transl. of "Splavy Na Osnove Tugoplavkikh Soedineniy" Moscow, Gos. Nauchn.-Tekhn. Izd., 1961
(FTD-TT-62-430/1+2)

This review of high-temperature alloys covers the following areas: identification; properties; production technology; binary metal-like alloys of boride, carbide, nitride, and silicide; nonmetallic high-melting alloys; coatings based on boriding, siliciding, carbiding, and nitriding; and examples of the use of high-melting alloys in industry. R.C.M.

N63-13183 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TENSILE PROPERTIES AND SHEET-BENDING FATIGUE PROPERTIES OF SOME REFRACTORY METALS AT ROOM TEMPERATURE

Lee R. Foster, Jr., and Bland A. Stein Washington, NASA, Jan. 1963 32 p 5 refs
(NASA TN D-1592) OTS: $1.00

Results of tensile stress-strain tests and completely reversed sheet-bending fatigue tests conducted at room temperature on unnotched sheet specimens of Ta-10W tantalum alloy, D-31 niobium alloy, pure tungsten, and Mo-0.5Ti molybdenum alloy are presented. Fatigue data from tests on similar specimens of 2024-T3 aluminum alloy and 17-7 PH stainless steel are compared with previous data from axial-load tests on larger specimens of these materials to determine whether the small size of the specimens used in this investigation produces representative results. Comparisons of the various materials on the basis of applied-stress—ultimate-strength and strength-density ratio also are presented. Author

N63-13198 Thompson Ramo Wooldridge, Inc. TAPCO Div., Cleveland, Ohio

DEVELOPMENT AND TESTING OF TUNGSTEN EMITTERS FOR ION PROPULSION SYSTEMS [Final] Technical Documentary Report [May 15, 1961-July 31, 1962]

R. H. Hiltz, J. M. Gerken and F. J. Lally Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Oct. 1962 68 p 3 refs
(Contract AF 33(616)-8297)
(ASD-TDR-62-756)

A process is presented for the production of porous tungsten-emitter discs with a pore spectrum of 0.7 to 0.9 microns and a mean pore diameter of 0.8 microns. Studies of joining the emitter discs to refractory metal plenum chamber by electron beam welding were conducted. Work was performed on both tungsten and columbium plenum chambers, and in both cases embrittlement was a serious problem. Although difficulties were encountered in successfully welding round emitters into the plenum chamber, sufficient assemblies were prepared for testing. Assemblies successfully withstood 100-hour exposure at 2500° F in a cesium atmosphere. An initial ion efficiency of 98.4% was obtained, but due to poisoning the ion efficiency decreased with increasing time at temperature. Author

N63-13209 ManLabs., Inc., Cambridge, Mass.

MECHANICAL BEHAVIOR OF INTERMETALLIC COMPOUNDS [Interim Report, Oct. 15, 1961-Oct. 14, 1962]

P. Stark, J. Ryan, and S. V. Radcliffe Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Jan. 1963 91 p 52 refs (Contract AF 33(657)-7432)
(ASD-TDR-62-1087, Pt. I)

Melting, casting, and fabrication techniques have been developed for the preparation of the intermetallic compounds VNi_3 and VCo_3 in a form suitable for the study of mechanical behavior. The annealing behavior of arc-melted, rolled, and extruded materials has been examined using metallographic and hardness techniques. The mechanical behavior of cast and extruded material of various grain size and degrees of order has been determined by indentation stress-strain, compression and tensile testing, and fractography. Arc-melted ingots of VNi_3, V_2Ni, V_3Ni, VCo and V_3Co have been prepared, and the feasibility of their homogenization and fabrication examined. An extensive review of the relevant literature has been completed. Finally, the validity of a method of computing Young's modulus for intermetallic compounds has been investigated. Author

N63-13245 Aeronautical Systems Div. Metals and Ceramics Lab., Wright-Patterson AFB, Ohio

STRAIN AGING EFFECTS IN COLUMBIUM DUE TO HYDROGEN

Benjamin A. Wilcox *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 137-154 52 refs (See N63-13234 07-01)

The strain aging tendencies of recrystallized, fine-grained arc-cast columbium have been investigated using two different experimental techniques, the feasibility and accuracy of both methods having first been evaluated by tests on 1020 steel. Tensile straining (up to about one percent strain) at -50° C revealed the characteristic upper and lower yield point found in BCC metals, this effect being attributed to "Cottrell Locking" of dislocations by atmospheres of interstitial atoms. Immediate re-straining of the samples showed no yield-point effect since the dislocations were already unpinned, but suitable aging treatments (121°-260° C) caused the yield point to return as a result of dislocations being relocked. The aging temperature dependence of the rate of yield-point return was evaluated, and an activation energy of 10,500 cal/mole was determined for the process. This value is considerably lower than the activation energies for diffusion of carbon, oxygen, and nitrogen in columbium, but in good agreement with the value given by Albrecht for hydrogen diffusion in Cb (Q=9370 cal/mole). It is therefore concluded that hydrogen can be responsible for strain aging in columbium. This finding disagrees with the results of Begeley who used a similar technique to determine an activation energy of 27,100 cal/mole for the temperature dependence of the rate of yield-point return in columbium. His conclusion was that oxygen was responsible for the strain aging effects. The ability of hydrogen to cause dislocation pinning in columbium was further substantiated by using dynamic modulus measurements to study the strain aging process. Author

N63-13247 Aeronautical Systems Div. Metals and Ceramics Lab., Wright-Patterson AFB, Ohio

INITIAL YIELDING AND FRACTURE IN NOTCHED SHEET MOLYBDENUM

Robert T. Ault *In* Library of Congress. Science and Technology Div., Washington, D.C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 189-219 49 refs (See N63-13234 07-01)

The initial yielding and fracture initiation behavior of wrought stress-relieved and recrystallized molybdenum were investigated at room temperature. The effect of notch severity and grain size on the nature of plastic flow in notched sheet tensile specimens was investigated by means of photoelastic coatings. The nature of fracture initiation in notched sheet tensile specimens was studied through the use of pre-polished and etched tandem notch specimens. Application of the Griffith-Orowan theory for crack propagation and the Cottrell criterion for crack initiation reveal that the effective surface energies for crack propagation and crack initiation are the same order of magnitude, [which is] 10^3 ergs/cm^2. This finding is supported by the experimental observation that no microcracks were found. Plastic flow regions determined experimentally from the photoelastic coating studies were shown to be in good agreement, both qualitatively and quantitatively, with theoretical results predicted by elastic-plastic stress analyses. Initial yielding at the notch root was found to occur at the same nominal stress level for a given material condition, independent of the magnitude of the stress concentration factor. This nominal stress in the notch section was nearly equal to the smooth tensile yield stress. Author

N63-13267 European Atomic Energy Community, Brussels (Belgium)

CONTRIBUTION A L'ÉTUDE DU SYSTÈME NIOBIUM/ALUMINIUM [CONTRIBUTION TO THE STUDY OF THE NIOBIUM/ALUMINIUM SYSTEM]

M. J. Richards Jan. 1963 12 p 11 refs In French; English Summary Presented at the Journées Métallurgiques d'Automne, Paris, Oct. 15-19, 1962
(Contract EURATOM 023-61-7 ORGB)
(EUR-132.f) Available from Belgian-American Bank and Trust Co., N.Y., account No. 121.86: 40 Belg. Fr.

Alloys covering the entire range of composition between pure Al and pure Nb were prepared by argon-arc melting using a nonconsumable tungsten electrode. It was, however, not possible to prepare alloys containing a high percentage of Nb (over 40 at %) directly from the two pure metals, and it was found necessary to start from Nb and a parent alloy containing about 47 wt % Al (corresponding roughly to the compound $NbAl_3$). This method made it possible to achieve a considerable reduction in the Al losses resulting from volatilization in the course of the melting process. The alloys were heat-treated in a tantalum resistance furnace up to 1,800° C. This furnace makes it possible to quench the sample in vacuo in a liquid metal bath. The Al losses resulting from surface evaporation were reduced by means of a special preparation of the sample before the vacuum treatment. Metallographic and radiocrystallographic examinations were carried out on the alloys. A novel dilatometric method has been devised for the rapid determination of the solidus temperature in the Al-rich region; the use of this method was made possible by means of a high sensitivity, instant-reading electrical inductive-trap dilatometer. The eutectic $NbAl_3$-Al reaction and the eutectic reaction between the compounds $NbAl_3$ and Nb_2Al were confirmed. It was possible to identify the Nb_3Al and Nb_2Al phases in the Nb-rich region. The equilibrium of the phases in this region was, however, found to be more complicated than reported in previous publications since it must, in particular, account for solid-state transformations in the intermetallic compounds. Author

N63-13274 Universal-Cyclops Steel Corp. Refractomet Div., Bridgeville, Pa.

MOLYBDENUM SHEET ROLLING PROGRAM Technical Interim Report No. 19, Covering Period Oct. 26, 1962 to Jan. 25, 1963

Jan. 25, 1963 52 p

(Contract NOas 59-6142-c)

Ten sheets of 0.060- × 24- × 72-in. Mo+0.5%Ti have been produced. All sheets required for Phase II TZM rolling studies have been produced. Author

N63-13279 Virginia Polytechnic Inst., Blacksburg

EFFECT OF NITROGEN ON THE STRAIN BEHAVIOR OF AISI 304 STAINLESS STEEL UNDER LOW STRESSES IN THE TEMPERATURE RANGE 80° TO 170° C

William H. Herrnstein, III (M. S. Thesis) June 1962 50 p 15 refs

The effect of nitrogen on the strain behavior of AISI 304 austenitic stainless steel under low stresses is of interest in the temperature range 80° to 170° C from the standpoint of accounting for the susceptibility of this alloy to stress-corrosion cracking. Heating tests were conducted on unnitrided and nitrided 304 sheet specimens under low static stresses in the temperature range of interest. Specimen strain was measured as a function of temperature during heating. An abrupt decrease in the slope of the strain versus temperature curve was observed for each specimen tested. Furthermore, the temperature at which these decreases occurred appeared to be dependent upon the heat treatment and applied stress, the temperature decreasing with both nitriding exposure time and applied stress. Discussion is presented concerning the possibility that stress-induced diffusion of interstitial nitrogen is involved with the observed phenomena. Author

N63-13300 Naval Ordnance Lab., White Oak, Md.

REVIEW OF ALUMINUM-IRON MAGNETIC ALLOYS AND ASSOCIATED SYSTEMS (0 TO 10% ALUMINUM)

H. H. Helms, Jr. Oct. 23, 1962 94 p 99 refs

(NOLTR-62-144)

Research results on the iron-aluminum magnetic-alloy system, with main emphasis on those alloys containing from 0% to 10% aluminum by weight, are presented. The study indicates that: low-percentage aluminum-iron alloys demonstrate excellent behavior when exposed to nuclear radiation, temperature, and mechanical stress; show no detrimental order-disorder transformations during cooling cycle variations; and respond favorably to magnetic annealing processes. These alloys have an inherent ductility advantage over the silicon iron alloys thus making the processing into sheet much easier. They also respond favorably to special crystalline orientation techniques. Indications are that this family of alloys will offer considerable resistance to nuclear radiation environments and they are not subject to induced radioactivity as is the case of the cobalt bearing magnetic alloys. Author

N63-13305 Aerojet-General Nucleonics, San Ramon, Calif.

ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM: COMPATIBILITY TESTS WITH HASTELLOY X IN OIL-CONTAMINATED GASES

J. S. Brunhouse and G. W. Titus Jan. 1963 69 p 3 refs

(Contract AT(10-1)-880)

(AGN-TM-401) OTS: $1.75

Hastelloy X sheet and tubing materials were exposed at 1750° F to gases contaminated with lubricating oil in order to determine the compatibility of the Hastelloy X cladding on ML-1 fuel elements with coolant gases contaminated by possible leakage of oil from the turbine or compressor. The gases used were nitrogen, the ML-1 reference gas (99.5 vol% N_2 + 0.5 vol% O_2), and argon. Samples were evaluated by metallographic examination, chemical analysis, X-ray diffraction analysis, weight change measurements, and tensile testing. It was concluded that Hastelloy X appears to have good compatibility with a coolant contaminated with minor quantities of oil vapor if oxygen is present in the coolant gas. Author

N63-13311 Bureau of Mines. Reno Metallurgy Research Center, Nev.

RADIOTRACER APPLICATIONS IN ELECTROMETALLURGICAL PROCESSING

Kenneth G. Broadhead and Howard H. Heady 1963 18 p 14 refs

(BM-RI-6195)

Four applications of radiotracer techniques in metallurgical research are described: (1) In electrowinning tungsten from scheelite, molybdenum 99 was used to determine the molybdenum concentration of the fused alkali-phosphate bath and the electrowon tungsten; (2) an attempt to determine the solubility of tagged ceric oxide in molten CeF_3-BaF_2-LiF was unsuccessful, but a high rate of cerium ion exchange was observed; (3) iron 59 was added to cerium during casting and used to follow the migration of iron during solid state electrolysis; (4) radiotracers were used in developing special analytical techniques applicable to high-purity rare-earth metals produced by molten salt electrolysis. Author

19 MATERIALS, NONMETALLIC

Includes: mechanical and physical properties of non-metals (e.g., plastics).

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-12923 Union Carbide Europa S. A., Geneva (Switzerland)

THE EFFECT OF VARIOUS SILANE COUPLING AGENTS ON THE PROPERTIES OF GLASS REINFORCED PLASTICS

Mario Jösler [1962] 16 p 13 refs Presented at the Fourteenth International Congress on Plastic Materials, Torino, Sept. 26-28, 1962

The effect of various silane coupling agents on the properties of glass reinforced plastics was studied. Most of the work was done with vinyl and aminosilane coupling agents. Also, results were obtained with new epoxy and acrylate-modified silanes. The postulated "chemical bridge" mechanism for coupling agents between glass and rosin seems to fit the facts of glass-rosin laminate performance. Superior results were obtained using coupling agents having functional groups that can react with suitable groups in the rosin. New silanes acting as coupling agents with polyester rosins offer the first major improvement in glass-polyester systems since the introduction of vinyl silanes. Stronger epoxy laminates can be made with the new silanes, but the improvement is less impressive than that achieved for polyester laminates. J.R.C.

N63-12999 Battelle Memorial Inst., Columbus, Ohio

RADIATION-INDUCED CHANGES IN POLYMERS AND THEIR INFLUENCE ON GRAFT POLYMERIZATION

Francis A. Sliemers, Jr., John F. Kircher, Robert Lieberman, Richard Markle, William B. Gager, Manfred Luttinger, and Robert I. Leininger

Jan. 22, 1963 37 p 11 refs

(Contract W-7405-eng-92)

(BMI-1610) OTS: $1.00

The preparation and irradiation behavior of a number of polymers, particularly those of the acrylate and methacrylate families, were studied. Particular emphasis was placed on the role of structural factors and their importance in the investigation of radiation susceptibility. It was found that polymer molecular weight influences site formation. Site concentration is quite markedly affected by dose rate. Cyclization of the pendant-ester group has somewhat the same effect

as has chain branching. Comparison of the EPR spectra of methacrylate polymers having cyclic ester groups with those having acrylic pendant structures suggests mechanistic differences associated with free-radical formation. Poly-2-hydroxypropylmethacrylate was examined in a continuation of investigations of structural effects and found to produce a type of EPR spectrum that would not be predicted from conventional structural considerations. In addition to an investigation of the mechanism of free-radical formation, postirradiation graft-copolymerization reactions were examined. Direct grafting methods as well as vapor-phase and peroxide-initiated copolymerizations were studied. Author

N63-13205 Princeton U. Frick Chemical Lab., N.J.
ASPECTS OF VISCOELASTICITY OF POLYMERS
Arthur V. Tobolsky Feb. 1963 10 refs Submitted for Publication
(Contract Nonr-1858(07))
(ONR-TR-RLT-58)

Various aspects of the viscoelasticity of amorphous, amorphous cross-linked, and semicrystalline polymers are discussed. Modulus-temperature curves are presented for linear amorphous polymers. These curves show flow regions (glassy, transition, rubbery plateau, rubbery) for polystyrene, natural rubber, ethylene tetrasulfide, and polymethyl acrylate. The mechanisms of cross-linking are discussed, and the effects of cross-linking agents such as EGDM upon the modulus temperature of amorphous polymers is demonstrated. The properties of crystalline polymers depend upon the previous thermal history of the polymer; but, since the crystalline regions act both as cross-links and as rigid filler particles, these polymers offer a useful combination of high modulus and high impact strength. M.P.G.

N63-13207 Atomics International, Canoga Park, Calif.
HIGH TEMPERATURE PHASE TRANSFORMATION IN BERYLLIUM OXIDE: THERMAL ARREST MEASUREMENTS AEC Research and Development Report
S. B. Austerman Feb. 15, 1963 20 p 6 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7654) OTS: $0.50

Beryllium oxide exhibits a thermal arrest during rapid heating and cooling in the vicinity of 2100° C. This is evidence of a high-temperature phase transformation, which has also been detected by other means. The latent heat of transformation was measured to be 50 ± 10 cal/g of BeO, based upon a specific heat of 0.577 cal/g at 2100° C for BeO. Author

20 MATHEMATICS

Includes: calculation methods and theory; computers; data processing; and numerical analysis.

For related information see: 08 Communications; 09 Electronics; 10 Facilities; and 22 Navigation and Guidance.

N63-12906 Pennsylvania State U. Ordnance Research Lab., University Park
A DIGITAL SYSTEM FOR DATA COLLECTION, REDUCTION, AND ANALYSIS
Francis P. Finlon Jan. 15, 1963 29 p
(Contract NOrd-16597)

The Ordnance Research Laboratory has developed equipment and facilities to record, reduce and analyze test data. The data-recording system converts the data from 45 analog signal sources to digital form and records the digital data on tape. The equipment is small enough to be installed in a torpedo. The field data-reduction system permits in-the-field evaluation of the test data. The laboratory data-reduction system includes a general-purpose digital computer. Both the present and projected capabilities of this system are described. Author

N63-12992 Los Alamos Scientific Lab., N. Mex.
A CODE FOR REDUCING MANY-GROUP CROSS SECTIONS TO FEW GROUPS
Ralph S. Cooper Feb. 11, 1963 51 p
(Contract W-7405-eng-36)
(LAMS-2801; supersedes LAMS-2747) OTS: $1.25

A code (ZOT) has been written which will produce few-group neutron cross sections from many-group sets based on a given flux spectrum or one computed for an infinite medium. The cross-section format is that of S_n transport theory including the possibility of upscattering in energy. The code is written in the Floco II system for use on the IBM 704 or IBM 7090. Author

N63-13016 Autonetics. Research and Development Div., Downey, Calif.
COMPUTERS IN SPACE
C. F. O'Donnell Feb. 1963 43 p 3 refs

This paper summarizes the challenging problems facing engineers in designing computers for space. It outlines the requirements for computers in control, navigation, and data processing for a hypothetical representative space flight, and discusses the characteristics of computers dictated by these requirements—their accuracies, solution rates, and capacities. The effect of the alien physical environment on the actual equipment is explored, and problem areas are determined. The design problem posed by the reliability needed in computers which must function successfully, possibly for several months, is pointed out. Author

N63-13020 Northeastern U., Boston, Mass.
EXAMPLES OF P. D. F.'S OF SUMS AND PRODUCTS Scientific Report No. 2
Sze-Hou Chang and Lih-Jyh Weng Sept. 1962 34 p
(Contract AF 19(604)-7494; Grant AF-AFOSR-62-371)
(AFCRL-62-795)

The calculations of the probability density functions (p.d.f.'s) of the sums and products of random variables are demonstrated. The random variables are selected pair-wise from the triangular, gaussian, rectangular, and sinusoidal variables whose probability density functions are given. There are altogether 10 different pairs for the sums and the same number of pairs for the products. The p.d.f.'s are calculated respectively for the sums and products of the pairs of variables which are considered statistically independent. The gaussian-gaussian combination is treated for the case when the two gaussian variables are dependent, as expressed by their covariance matrix. The sinusoidal-sinusoidal combination is treated for the case when the two sinusoidal variables are dependent. J.R.C.

N63-13026 Dow Chemical Co. Rocky Flats Div., Denver, Colo.
COMPUTER PROGRAM TO PERFORM FOURIER ANALYSIS OF X-RAY DATA
C. L. Bell, A. Goodwin, Jr., and G. R. Mallet Feb. 4, 1963 23 p 1 ref
(Contract AT(29-1)-1106)
(RFP-297) OTS: $0.50

A short mathematical outline is given for the determination of Fourier coefficients for corrections of widths and shapes of lines from X-ray diffractograms. The computer program discussed applies to the Bendix G-15D computer. The program will calculate the Fourier coefficients $\bar{U}_r(z)$ and $\bar{U}_i(z)$ for the corrected distribution. Author

N63-13039 Army Missile Command. Guidance and Control Lab., Redstone Arsenal, Ala.

LOGIC AND CIRCUIT CONSIDERATIONS IN THE DESIGN OF A DIGITAL DIFFERENTIAL ANALYZER TO BE USED AS A TEST TOOL FOR EVALUATION OF ADVANCED MEMORY DEVICES

John R. Williams Jan. 16, 1963 21 p
(RG-TR-63-8)

This report deals with the technical design and problems encountered in the building of a Digital Differential Analyzer (DDA), a test tool for evaluation of advanced memory devices, digital-to-analog and analog-to-digital converters. The first step in building the test tool was to select a particular guidance scheme to mechanize. The Pershing Missile Guidance was instrumented for this purpose. In order to simplify the building of the DDA, commercial digital modules were used as the basic components. The logical design, construction, and testing of all the circuits were completed, and all units operated satisfactorily. In order to make accuracy tests with actual acceleration profiles it was necessary to construct a device to serve as a buffer between the DDA and a general purpose digital machine which would provide the proper input data. Author

N63-13078 Navy Electronics Lab., San Diego, Calif.

AN ELECTRONIC GENERATOR OF RANDOM NUMBERS

G. M. Dillard and R. E. Simpson Dec. 21, 1962 24 p 6 refs
(NEL-1152)

An electronic generator of random numbers has been constructed and evaluated. The device has been used to generate a sequence of ones and zeros with a predetermined probability of a one in the evaluation of an experimental sequential detector, and also to generate random sequences of ones and zeros in simulating the input to an experimental track-before-detect system being developed at NEL. Results of laboratory experiments employing the generator are described. Author

N63-13095 Naval Postgraduate School, Monterey, Calif.

GRAPHICAL FOURIER OPERATIONS

Roy M. Johnson, Jr. Oct. 1962 26 p
(Supported by ONR)
(*Its* Research Paper No. 31)

The graphical, symbolic function method of evaluating the discrete or continuous Fourier spectrum of a function is proved by use of symbolic analysis. After a review of pertinent symbolic function theory, the method is illustrated for several problems including the nonfinite polynomial function case. Author

N63-13165 California U., Berkeley. Electronics Research Lab.

ON THE ROOTS OF A REAL POLYNOMIAL INSIDE THE UNIT CIRCLE AND A STABILITY CRITERION FOR LINEAR DISCRETE SYSTEMS

E. I. Jury and J. Blanchard Dec. 26, 1961 32 p 16 refs
(Grant AF-AFOSR-62-70)
(AFOSR 2443; IER Ser. 60, Issue 425)

Necessary and sufficient algebraic conditions for the roots of a real polynomial to lie inside the unit circle, in a table form, are given. In this form, the constraints are obtained only by evaluation of second order determinants. The connection and identity between the stability criterion established in this paper and of a previously obtained criterion are obtained. The table is valuable if the coefficients of the real polynomial are given in numbers. It is similar to Routh's table obtained for the continuous case. Conditions on the numbers of the roots inside, outside, or on the unit circle are also discussed, under the cases when the determinants are zero or nonzero. Furthermore, necessary and sufficient conditions are formulated for all the roots to be inside a circle of radius σ or less than unity, and also the conditions when the roots are to lie between plus and minus unity in the z-plane. Various analytical stability criteria applied to linear discrete systems are enumerated and compared, with emphasis on the advantageous applications of each of the various criteria. Author

N63-13204 Rome Air Development Center. Information Processing Lab., Griffiss AFB, N. Y.

THE STORAGE, RETRIEVAL, AND UTILIZATION OF A SERVICE ROUTINE LIBRARY FOR THE RADC CDC 160/160A COMPUTER SYSTEM

Frederick A. Normand and Casper R. De Fiore Feb. 1963 31 p
(RAW-TM-63-2)

The storage, retrieval, and utilization of a service routine library for the Rome Air Development Center CDC 160/160A computer system is reviewed. Programs which become part of the library can be shared by programers, thus increasing program utilization. The program library routines can be executed anywhere in core, giving the programer more flexibility in using the program library. With just one magnetic-tape read routine, any of the routines can be read into core. Also, with just one magnetic-tape write routine all routines can be written on magnetic tape. J.R.C.

N63-13224 Carnegie Inst. of Tech., Pittsburgh, Pa.

A CONVOLUTION PRODUCT FOR DISCRETE FUNCTION THEORY

R. J. Duffin and C. S. Duris July 12, 1962 38 p 10 refs
(Contract DA-ARO(D)-31-124-G78)
(AROD-223-59)

Complex-valued functions, defined at the points of the complex plane with integer coordinates, are described. The functions of particular interest, called discrete analytic functions, satisfy difference equations analogous to the Cauchy-Riemann equations. The usual product of two functions does not preserve discrete analyticity. A "convolution product" is defined. This product is commutative, associative, and distributive, and it preserves analyticity. Two other similar "products" are also investigated. These are termed "hyper-convolution products" and have properties similar to the convolution product. With the machinery of the convolution product, a discrete theory analogous to that of Volterra integral equations is developed. Discrete derivative equations are introduced and studied using the "integral equation" theory mentioned. A theory similar to Laplace transforms is also presented. Using this theory, some discrete functions, defined on the positive integers, can be extended to discrete analytic functions in the complex plane. Author

N63-13227 International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N.Y.

ADAM—A PROBLEM ORIENTED SYMBOL PROCESSOR Scientific Report No. 1

Rex Rice Dec. 20, 1962 41 p
(Contract AF 19(628)-1621)
(AFCRL-62-964)

A study of the general area of problem solving with a digital computer revealed characteristics of data that are essentially ignored or suppressed in conventional systems. In an attempt to increase the capability and flexibility of a digital system, a new high-level language has been defined which utilizes these data characteristics. A machine organization which implements this language as a machine language, and yet imposes no restrictions on the use of the language, has been proposed. The system will have the following characteristics as a result of this organization:

(1) *Complete symbolic addressing on variable field length data.* This addressing scheme eliminates any consideration of the physical location of the data in the system once the system has ever seen the data.

(2) *List and string operations.* These operations include arithmetic operations as well as those such as deletion, insertion, union, intersection, etc.

(3) *High to low order numeric processing.* This technique permits all data to be handled in exactly the same way.

(4) *Dynamic storage allocation.* The machine assigns all storage and maintains a continuously updated blank or availability list.

(5) *Automatic input-output.* Machine control of the storage of variable field length data and instructions necessitates a procedure for machine control of input-output functions. Author

N63-13229 France. Ministere de l'Air, Paris

PROPRIÉTÉS ARITHMÉTIQUES DÉDUITES D'UNE PRÉSENTATION SIMPLIFIÉE DE LA FORMULE DU BINOME [ARITHMETICAL PROPERTIES DEDUCED FROM A SIMPLIFIED PRESENTATION OF THE BINOMIAL THEOREM]

Stéphane Thouvenot Paris, Service de Documentation et d'Information Technique de l'Aéronautique, [Aug.] 1962 180 p 3 refs In French

(*Its* Publications Scientifiques et Techniques No. 388) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

The classic binomial theorem is shown to be simplified considerably by using the auxiliary variables w and t. This leads to proof of the existence of an invariant of the form $Q_N(w^2, t^2) \equiv O(N)$ that can be associated with each prime number N; the invariant in turn gives characteristic properties of integral numbers $N = 6p + 1$. The other invariants are defined for the case of the numbers $x_1, \ldots x_t$, which permit studying congruent equations to any degree and formulating for any of these equations the sum of the powers of their roots.

M.P.G.

N63-13262 Case Inst. of Tech. Numerical Control Lab., Cleveland, Ohio

A THEORY OF SEQUENTIAL PATTERN RECOGNITION

James L. Costanza and Harry W. Mergler June 1962 180 p 29 refs Submitted for Publication

(NASA Grant NsG-36-60)

(EDC-1-62-14)

The logical organization and functional design considerations of a pattern recognition system are presented. It is proposed to effect pattern recognition by a process of sequentially scanning a pattern field which is considered as quantized into a finite number of areas. It is shown that because of redundancy present in the specification of a pattern, it will not be necessary, in general, to interrogate the entire pattern field to effect reocgnition. Taking advantage of the pattern field's finite structure, it is possible to formulate the mechanism of pattern recognition in terms of a finite state, sequential automata. In so doing, it is possible to define a measure of system performance in terms of the mean number of pattern field interrogations required to effect recognition. The system performance is found to be closely associated with the scanning policy used during the course of the sequential pattern field interrogation. A method of computing an optimum scanning policy is developed which, if used, results in an optimum system performance. Experimental verification of the techniques proposed is included. Author

N63-13270 Stanford U. Applied Mathematics and Statistics Labs., Calif.

FUNCTION ALGEBRAS

H. L. Royden Jan. 21, 1963 26 p 76 refs

(Contract DA-ARO(D)-31-124-G80)

(Tech. Rept. 21; AROD-1323-24)

A general treatment is given of function algebras previously studied by various investigators. An illustration is given of the application of methods from the theory of functions of several complex variables to derive results about nonself adjoint function algebras. A theorem is given which describes the one-dimensional cohomology of the spectrum of a Banach algebra in terms of the group of invertible elements of the algebra. Author

N63-13283 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

A NUMERICAL SOLUTION OF THE PROBLEM OF MIXING OF LAMINAR COAXIAL STREAMS OF GREATLY DIFFERENT DENSITIES—ISOTHERMAL CASE

Herbert Weinstein and Carroll A. Todd Washington, NASA, Feb. 1963 27 p 7 refs

(NASA TN D-1534) OTS: $0.75

The system under consideration is a slow-moving, heavy inner stream surrounded by a fast-moving, light outer stream infinite in extent. The flow region of interest lies between the inner jet entrance and the end of the potential core. The density ratio of the two streams may vary through several orders of magnitude, and no restrictions are placed on the velocities of the two components. The only information required is the initial velocity and concentration profiles and the physical properties of the fluids. An equation set is derived and solved numerically for several sets of input parameters. A system of equations that is not extremely sensitive to physical property variations results from the manner in which the variables are made dimensionless. A diffusion equation valid for high values of the density ratio is employed. No consideration is given to the hydrodynamic stability of the system. Results are calculated for a given set of physical properties and a range of values of density and velocity ratio. These results include the following: (1) The potential core length is approximately 6 radii for fluids of the same density and a velocity ratio of 100. (2) For values of density ratio above 20, the effect of varying density ratio is small. (3) For Froude numbers of 10^2 or less, the mass and momentum transfer become second-order effects compared to the acceleration due to the force field. (4) Large changes in the values of physical properties of the two fluids cause relatively small changes in potential core length. Author

N63-13294 Naval Ordnance Lab., White Oak, Md.

THE EXISTENCE AND CALCULATION OF SOLUTIONS OF CERTAIN INTEGRO-DIFFERENTIAL EQUATIONS IN SEVERAL DIMENSIONS

A. Douglis Dec. 4, 1962 65 p 4 refs

(NOLTR-62-193; Math Dept. Rept. M-32)

Boundary and initial-value problems are solved for linear integrodifferential equations in several dimensions of a type including linearized forms of Boltzmann's equation. The methods of calculation are based on finite differences and are thus suitable for calculation. Author

N63-13308 Brown U. Div. of Applied Mathematics, Providence, R.I.

VARIATIONAL PRINCIPLES IN THE LINEAR THEORY OF VISCOELASTICITY Technical Report No. 18

M. E. Gurtin Jan. 1963 26 p 18 refs

(Contract Nonr-562(25))

This paper is a continuation of a study which contains a systematic treatment of linear viscoelasticity theory based on the notion of Stieltjes convolution. Discussed are: (1) preliminary definitions and notational agreements; (2) variable principles appropriate to the linear quasi-static theory of viscoelastic solids given for the case in which stress-strain relations are in relaxation integral form; and (3) derivation of analogous results for stress-strain relations in creep integral form. In the variational principles established, the viscoelastic solid is allowed to be inhomogeneous and anisotropic; the relevant stress, strain, and displacement histories are permitted to possess finite jump discontinuites in time. I.v.L.

N63-13310 Argonne National Lab., Ill.

TRANSIENT ANALYSIS OF TWO-PHASE NATURAL-CIRCULATION SYSTEMS

R. P. Anderson, L. T. Bryant, J. C. Carter, and J. F. Marchaterre Dec. 1962 41 p 12 refs

(Contract W-31-109-eng-38)

(ANL-6653)

A technique is presented for solving the equations of a natural-circulation system. The solutions are compared with experimental results at various pressures with two geometries in boiling water systems. The solutions meet the established criteria. The analog model is useful for predicting the behavior of two-phase natural-circulation systems during transients. The model accurately predicts the point at which such systems exhibit oscillatory behavior. The results were

found to be sensitive to the vapor-liquid velocity ratio (slip ratio) used in the computation. The velocity ratio correlation used in the model is presented. All computations, circuits, and operating information necessary to duplicate the experiment are given. Author

21 METEOROLOGY

Includes: climatology; weather forecasting; lower atmosphere studies; and oceanography.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N63-12971 National Aeronautics and Space Administration, Washington, D.C.

U. S. STANDARD ATMOSPHERE, 1962 ANNOUNCED News Release No. 63-35

Feb. 25, 1963 5 p

A detailed report on the earth's atmosphere—intended to meet the needs of space age research and operations—is now available, according to NASA. Called "U.S. Standard atmosphere, 1962," all data are presented in both metric and English units. The report is intended for international application in aircraft altimeter calibration, aircraft and rocket design, aeronomy, and space research. A.R.B.

N63-13010 Navy Electronics Lab., San Diego, Calif.

OPTICAL PROPERTIES OF THE BERING SEA NAVAL ENVIRONMENT, JANUARY – FEBRUARY 1960

J. M. Hood, Jr. Dec. 18, 1962 45 p 10 refs

(NEL-1150)

As part of a continuing research into the geo-optics of the polar naval environment, optical and meteorological data were collected during 1960 winter naval exercises in the Bering Sea. The data have been analyzed and interpreted, and can now be used for the prediction of conditions influencing visibility, photographic and photoelectric surveillance, and equipment and personnel operations.

Author

N63-13112 Weapons Research Establishment (Australia)

SOME MEASUREMENTS OF WINDS IN THE UPPER ATMOSPHERE AT VARIOUS SEASONS, 1961-1962

P. H. O. Pearson Oct. 1962 33 p 5 refs

(Tech. Note SAD 100)

Measurements of winds in the region between 220,000 ft and 90,000 ft have been obtained at Woomera from three firings of upper atmosphere research rockets during summer, autumn, and winter periods in conjunction with the falling sphere method of measuring density. The winds were obtained by continuing to track the spheres with FPS16 radars below the region in which density measurements could be obtained. These values are presented together with the response calculations to wind velocity for the spheres, wind velocity and direction below 120,000 ft obtained from meteorological balloons, and the general weather pattern over Australia for the firing times. Author

N63-13265 Kaman Aircraft Corp. Kaman Nuclear Div., Colorado Springs, Colo.

TWO-POINT VARIABILITY OF WIND: VOLUMES I, II AND III Final Report

C. Eugene Buell July 1962 553 p 54 refs In 3 vols.

(Contract AF 19(604)-7282)

(AFCRL-62-889; KN-173-62-2(FR))

The variability of wind at two points is studied in terms of the components of the wind correlation tensor (correlation coefficient form) as functions of the relative positions of the point. When the points lie on the same isobaric surface and winds are observed simultaneously, the correlations may be approximated quite simply by an empirical expression containing two parameters, one involving the basic errors of observation and intensity of small scale eddies (size parameter less than 100 n mi) and the other a size parameter. The variation of the size parameter with isobaric level and season over the Northern Hemisphere is studied. The simplest form of these correlations is attained when winds are resolved into components along and across the line joining the two points concerned. When the two points are at different levels or the winds are observed at different times (or both), the usual resolution into longitudinal and meridional components appears to present as simple a description as may be obtained. In this case, other parameters must be added to account for the displacement of the correlation contours and the decay of correlation with level and time lags, and the large effect of nonhomogeneity of the wind field in the vertical. When the two points concerned are separated by less than 100 n mi (more or less), the effects of errors of observation and small-scale eddies require that the problem be handled differently. Doppler navigator winds observed at frequent intervals provide some information on two-point wind variability down to distances of a few miles and give some information on the structure of meso-scale eddies. Author

N63-13280 Michigan U. High Altitude Engineering Lab., Ann Arbor

ATMOSPHERIC SOUNDING BY SATELLITE MEASUREMENTS OF STELLAR REFRACTION Technical Report

F. F. Fischbach, M. E. Graves, P. B. Hays, G. S. Klein, C. M. Mizgala, and J. W. Peterson Dec. 1962 110 p 23 refs

(NASA Contract NASw-140; ORA Proj. 04963)

(Rept. 04963-3-T) OTS: $9.10 ph, $3.50 mf

A method of obtaining atmospheric density, temperature, and pressure profiles between 5- and 25-km by measuring the refraction of stellar images with satellite instrumentation is described. The daily location of observations over the earth's surface which may be obtained from a Nimbus-type orbit is shown. Instrumentation and data handling requirements are outlined. Current areas under investigation are described. Author

22 NAVIGATION AND GUIDANCE

Includes: autopilots; star tracking; inertial platforms; and traffic control.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.

N63-12902 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A SURVEY OF ATMOSPHERE REENTRY GUIDANCE AND CONTROL METHODS

Rodney C. Wingrove, N.Y., Inst. of the Aerospace Sciences, [1963] 28 p 88 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963

(IAS Paper-63-86) IAS: $0.50 members, $1.00 nonmembers

Methods for control of reentry vehicles in the atmosphere are surveyed to point out the dynamics of the guidance and control problem and possible solutions. The methods include those using automatic and pilot control. The survey shows that, independent of the particular guidance method, the four state variables should be represented in the guidance law to ensure control in sensitive guidance situations or markedly off-design conditions. Further research is warranted to determine which measurements should be used to represent the state variables and the best use of these variables in the guidance systems. R.C.M.

N63-12997 Army Missile Command. Guidance and Control Lab., Redstone Arsenal, Ala.

A SECOND STUDY ON REDUCTION OR ELIMINATION OF AIR CONDITIONING IN THE PERSHING GUIDANCE AND CONTROL COMPARTMENT

Peter Van Hoff and Russell T. Gambill Jan. 24, 1963 13 p
(RG-TR-63-4)

This report is on a second study to reduce or eliminate the air conditioning required by the Pershing Guidance and Control (G&C) Compartment. It contains a study of the hardware within the G&C Compartment operating at anticipated temperatures and suggests possible areas for component investigation and redesign. Author

N63-13099 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EQUATIONS FOR DETERMINING VEHICLE POSITION IN EARTH-MOON SPACE FROM SIMULTANEOUS ONBOARD OPTICAL MEASUREMENTS

Alton P. Mayo, Harold A. Hamer, and Margery E. Hannah Washington, NASA, Feb. 1963 33 p 4 refs
(NASA TN D-1604) OTS: $1.00

Equations for 13 different combinations of sightings are presented for determining the position vector of a vehicle in earth-moon space from simultaneous onboard optical measurements. The methods for reducing the measurements for position determination are basically triangulation methods and incorporate combinations of measurements made on either one, two, or three bodies (earth, moon, and sun). Angular measurements made at the vehicle consist of declination of a body, right ascension of a body, body angular diameter, and include angles between a star and body center, star and horizon, moon center and earth horizon, landmark and star, landmark and body center, orbiting beacon and star, and orbiting beacon and body center. The methods presented apply to the determination of the total position vector (distance and direction from a reference body). With the exception of one method, the methods do not require the use of a stable platform. Author

N63-13155 Army Missile Command. Guidance and Control Lab., Redstone Arsenal, Ala.

SIMULATION OF SINGLE AXIS INERTIAL REFERENCE SERVO LOOP WITH DIGITAL GYRO PICKOFF

Keith Crozier Jan. 10, 1963 12 p
(RG-TR-63-7)

The feasibility of the use of a digital gyro pickoff in an inertial reference servoloop is studied here. First, a standard inertial reference servoloop is simulated. The signal representing the gyro angle is then applied to an analog simulation of a digital encoder. The signal representing the encoder is then applied to the servoloop simulation as the pickoff output. The advantages of using a digital encoder as a gyro pickoff are: (1) reaction torques are absolutely zero; (2) null position is accurately repeated over long times and varied temperatures; (3) encoder material has a stable center of gravity; and (4) the gradient is exceptionally linear and repeatable. Author

23 PHYSICS, GENERAL

Includes: acoustics; cryogenics; optics; and thermodynamics.

For astrophysics see: 05 Astronomy and Astrophysics.

For related information see: 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 24 Physics, Solid-State.

N63-12921 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

INFLUENCE OF CORRELATIONS ON THE DIELECTRIC BEHAVIOR OF AN ELECTRON GAS. NONPERTURBATIVE APPROACH TO THE MANY-FERMION SYSTEM

Oldwig von Roos Repr. from Phys. Rev., v. 128, no. 2, Oct. 15, 1962 p 911-918 15 refs
(NASA Contract NAS7-100)
(JPL-TR-32-302)

Starting with the equation of motion for the density matrix operator of an electron gas in second quantization, a system of matrix equations is derived for matrix elements connecting states with various numbers of electron-hole pairs. Allowing up to n electron-hole pairs and neglecting all states with more than n pairs yields a set of $(n+1)^2$ coupled equations for the various amplitudes in close analogy to the nth order Tamm-Dancoff approximation. The starting point of this approximation, in which all matrix elements connecting the Fermi vacuum with any pair states are neglected (zero-order Tamm-Dancoff approximation), is an equation for the self-consistent field rather than for free particles as in the usual Tamm-Dancoff method. Correlation effects are therefore automatically taken into account when pair states are included. In a certain sense, the approximation scheme given here can be thought of as being an expansion in the deviation of the Fermi surface from the sharp edge of the free-particle ground state, the deviation being caused by the Coulomb interaction among the particles. In this paper, calculations are presented that are based on the first Tamm-Dancoff approximation (taking into account only one electron-hole pair). An expression for the dielectric constant will be derived and applied to a determination of the effects of correlations on the wavelength dependence of plasma oscillations. The theory will be compared with the experiments by Watanabe on the energy loss of fast electrons in metal foils, and it will be seen that the agreement with experiment is good considering the inherent simplicity of the theory. Author

N63-12925 Brookhaven National Lab., Upton, N.Y.

HIGH ENERGY ACCELERATOR PAPERS FROM USSR PREPARED FOR PRESENTATION AT 1961 INTERNATIONAL CONFERENCE

G. K. Green Oct. 1, 1962 304 p refs
(Sponsored by AEC)
(BNL 767(C-36)) OTS: $4.00

This report covers the following: magnetic measurements and methods of magnetic field corrections in a strong-focusing 7-Bev accelerator; electron systems for the 7-Bev strong-focusing proton synchrotron; automatic control system for the radial and phase position of a beam in the proton synchrotron; parameter of 50- to 70-Bev proton synchrotron; characteristics of 4- to 6-Bev electron synchrotron; design of 500-Bev proton synchrotron; two-stage 300-Bev proton circular accelerator; cyclic accelerators; coherent electron radiation in a synchrotron; acceleration of electrons in a plasma; loss of particles from the multiple coulomb scattering in cyclic accelerators; regenerative defector theory to a phasotron with azimuthal variation of magnetic field; analog computer for studying motion of particles in proton synchrotron; colliding beams without storage; compensation of nonlinear resonances in relativistic cyclotron; the symmetrical ring phasotron; particle motion in the ring phasotron; the spiral sector ring phasotron; high-current injector of hydrogen ions; ion sources with

plasma contraction by inhomogeneous field; acceleration and extraction of ions in a cyclotron; decrease of ion bunch duration and recurrence frequency of bunch in a cyclotron; and ion-beam energy spread. J.R.C.

N63-12939 California U., Berkeley. Lawrence Radiation Lab.
HYPERFINE STRUCTURES AND NUCLEAR MOMENTS OF Lu^{176m}, BR^{80}, Br^{80m}, AND I^{132}
Matthew B. White Sept. 1962 156 p 62 refs
(Contract W-7405-eng-48)
(UCRL-10321) OTS: $2.75

The method of Atomic-beam Radiofrequency Spectroscopy has been used to determine some nuclear and atomic properties of $Lu^{176\,m}$, Br^{80}, $Br^{80\,m}$, and I^{132}. Hyperfine structure measurements were made to determine the magnetic dipole interaction constants, a, and the electric quadrupole interaction constants, b, of all these isotopes. Also the nuclear spin, I, and the electronic g_j factor were measured for $Lu^{176\,m}$. Author

N63-12943 California U., Berkeley. Lawrence Radiation Lab.
ON THE NATURAL BOUNDARY OF THE SCATTERING AMPLITUDE
Jack Wong Dec. 1962 57 p 12 refs
(Contract W-7405-eng-48)
(URCL-10615) OTS: $1.25

In some current theories of elementary particle interactions, the elastic two-particle scattering amplitude on the second Riemann sheet of $\sqrt{s-4m^2}$, $\phi^{(2)}(s, \cos\theta)$, possesses singularities dense everywhere on the real negative s-axis for arbitrary complex $\cos\theta$. The real negative s-axis is therefore a natural boundary of $\phi^{(2)}(s,\cos\theta)$ for arbitrary $\cos\theta$, whereas the partial-wave amplitude $\phi_1^{(2)}(s)$ is known not to posses this natural boundary. Inspection of the integral defining $\phi_1^{(2)}(s)$ in terms of $\phi^{(2)}(s, \cos\theta)$ might lead one to expect $\phi_1^{(2)}$ $\phi_1^{(2)}(s)$ to possess the same singularities as $\phi^{(2)}(s, \cos\theta = \pm 1)$. In the present work the integral defining $\phi_1^{(2)}(s)$ is examined carefully, and it is demonstrated here why $\phi_1^{(2)}(s)$ does not possess the "expected" singularities. Author

N63-12960 Advanced Kinetics, Inc., Costa Mesa, Calif.
FAST GAS VALVE FOR PLASMA RESEARCH
R. S. Lowder and F. C. Hoh Repr. from Rev. Sci. Instr., v. 33, no. 11, Nov. 1962 p 1236-1238 4 refs
(NASA Contract NASw-427)

A new type of fast gas valve has been developed for plasma experiments requiring a rapid injection of gas into a vacuum. The valve can be opened and closed within 70 μsec and the gas injection is highly reproducible. A fast opening and closing of the valve, which consists of a low weight aluminum disk sealing against a soft O-ring, is achieved by energizing a coil placed on the O-ring side of the disk and allowing the disk to hit a nearby piece of aluminum and bounce back onto the O-ring. The density distribution of the expanding gas in the vacuum region near the valve was mapped out at particular times shortly after the opening of the valve by using a fast gas gage. Comparative measurements with a spring loaded valve showed the present valve to have a shorter opening time and much better reproducibility. Author

N63-12962 Case Inst. of Tech., Cleveland, Ohio
TRANSPORT THEORY OF NEUTRONS IN HEAVY GAS IN PLANE GEOMETRY. I. THE INFINITE MEDIUM AND CONSTANT TOTAL CROSS-SECTION
Roman S. Zelazny (Warsaw U.) May, 1962 20 p 5 refs Submitted for Publication
(NASA GRANT NsG-198-62)
(Tech. Rept. A-8) OTS: $1.60 ph, $0.80 mf

A general method is presented for a solution of neutron transport equation in heavy gas in plane geometry in the case of infinite medium and constant total cross section. This solution is based on the eigenfunction expansion method introduced originally in one-velocity transport theory by Case. The complete set of eigenfunctions has been derived, and the calculation of the Green function for Boltzmann equation in an infinite medium has been discussed. For total cross section slowly varying with energy, the perturbational procedure has been suggested. Author

N63-12967 Centre Européen pour les Recherches sur la Gravitation, Rome (Italy)
GRAVITATION. CAHIER G 6. NOTIZIARIO SPECIALE Supplement au "Bollettino Informazione A. S. A." [GRAVITATION. FOLIO G-6. SPECIAL NOTE. Supplement to the "Information Bulletin of the Associazione per le Scienze Astronautiche" (Rome)]
K. P. Stanyukovich et al Rome, Oct.-Dec., 1962 58 p refs Articles in English, French, and Italian

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N63-12988 Arizona U., Tucson
X-RAY FLUORESCENT YIELDS FROM SEVERAL LIGHT ELEMENTS
F. D. Davidson and Ralph W. G. Wyckoff Repr. from J. of Applied Phys., v. 33, no. 12, Dec. 1962 p 3528-3529 8 refs
(NASA Grant NsG-120-61)

Relative emissions and relative fluorescent efficiencies of excitation of K X-rays have been measured for various elements in the range between iron and oxygen. Agreement with theory is generally satisfactory. Author

N63-12990 Oak Ridge National Lab., Tenn.

NUCLEON-MESON CASCADE CALCULATIONS: SHIELDING AGAINST AN 800-MEV PROTON BEAM

R. G. Alsmiller, Jr., and J. E. Murphy Feb. 21, 1963 26 p 3 refs
(Contract W-7405-eng-26)
(ORNL-3406) OTS: $0.50

Nucleon-meson cascade calculations have been carried out and the dose as a function of depth has been obtained for an 800-Mev proton beam incident on a shield. The physical properties used for the shielding medium are only a rough approximation to the properties of any particular medium. Author

N63-12991 Los Alamos Scientific Lab., N. Mex.

QUANTITATIVE MEASUREMENT OF GAMMA-RAY-EMITTING RADIONUCLIDES IN METEORITES

M. W. Rowe Jan. 31, 1963 98 p 33 refs
(Contract W-7405-eng-36)
(LA-2765) OTS: $2.25

The gamma-ray spectra of 32 samples of 25 chondrites, 4 carbonaceous chondrites, and 9 achondrites have been investigated using a large NaI (Tl) scintillation spectrometer. Potassium and Al^{26} were the predominant radioactivities measured. More unusual gamma-ray emitters measured were 291-day Mn^{54}, 2.6-year Na^{22}, and probably a mixture of Sc^{46} and Co^{56} + ^{58} (half-lives approximately 80 days); these nuclides were detected in relatively recent falls (the youngest, the Harleton, Texas, chondrite, was measured 21 days after fall). Furthermore, thorium was detected and measured in 5 of the 9 achondrites. Of the 6 siderites studied, only Aroos and Sikhote-Alin showed detectable gamma radioactivity. In Aroos, measured 120 days after fall, Mn^{54} was the predominant radioactivity; Co^{60} was the only radioactivity measured in the 4 samples of Sikhote-Alin. In the other 4 old siderites, with a limit of detection of about 10 gammas/min/kg, no gamma-ray activity in the energy range 0.2 to 2 Mev was detectable. Quantitative data on radioactive concentration are presented. Author

N63-13046 California U., Livermore. Lawrence Radiation Lab.

THE IONIZATION OF ALKALI ATOMS BY ELECTRON BOMBARDMENT

F[orrest] S. Baker and G[ilbert] O. Brink (Pitt. U.) Oct. 17, 1962 57 p 42 refs
(Contract W-7405-eng-48)
(UCRL-7087) OTS: $1.25

A new experimental method has been developed by which relative measurements of ionization cross sections can be normalized to absolute values. The method consists essentially of combining crossed-beams techniques, adsorption of gases on solid surfaces, and radioisotope tracer detection. An atomic beam containing the radioactive tracer is crossed rectilinearly with an electron beam. The reaction products are adsorbed on collector surfaces and detected in a scintillation counter. The atomic beam is also quantitatively sampled by adsorption. Under consideration of experimental parameters, the value of the total ionization cross section is then directly proportional to the ratio of the counting rates R_{ion}/R_{beam}. The relative ionization cross-section curves of potassium, rubidium, and cesium have been normalized and are presented. The values of α for the relation $Q_i = \alpha E^{-\beta}$ expressing the simple ionization cross sections as a function of electron energy are also given. The total scattering cross sections of potassium, rubidium, and cesium have been partially resolved into their components. Finally, the autoionization structure of cesium is related to the known energy levels of the atom. Author

N63-13053 Rochester U. Inst. of Optics, N.Y.

A STUDY OF THE OPTICAL PROPERTIES OF SOLIDS IN THE EXTREME VACUUM ULTRAVIOLET AND/OR THE SOFT X-RAY REGIONS Final Report, 1 June 1960 to 31 October 1962

M. Parker Givens Jan. 8, 1963 5 p 4 refs
(Grant DA-ORD-17)
(AROD-2588-3)

A study was conducted to measure the absorption and reflection of solids in the spectral region between 100Å and 1500Å. Emphasis was placed on measuring the absorption of lithium fluoride and the reflection of the vitreous and metallic forms of selenium. The first exciton level in the fundamental absorption of lithium fluoride was found to be at 12.9 ev. Absorption structure, attributed to the fluoride's 2s electrons and lithium's 1s electrons, was observed. At the longer wavelengths (1000Å to 1500Å), both forms of selenium reflect about as well as glass (approximately 10%). The reflectivity of vitreous selenium-like glass falls to about 2% at 550Å. The reflectivity of metallic selenium falls to 0.1% near 600Å, and its reflectivity is not measurable at shorter wavelengths. J.R.C.

N63-13055 Michigan State U., East Lansing

THE PROPAGATION OF ULTRASONIC WAVES IN LIQUIDS Final Technical Report, 1 January 1962 to 31 December 1962

E. A. Hiedemann [1962] 5 p 7 refs
(Contract DA-ARO(D)-31-124-G246)
(AROD-2510-10)

An investigation of the propagation of ultrasonic waves in liquid by optical methods is reviewed and a bibliography of papers from this study are included. Both finite-amplitude continuous waves and pulsed waves were studied. The numerical results for continuous waves agreed with a theory developed for the diffraction of light by ultrasonic waves. A two-transducer fixed-distance method, devised for studying the fundamental frequency component of a finite amplitude pulsed wave, was found to be very useful for liquid-state investigations. R.C.M.

N63-13056 California U., Berkeley

THERMODYNAMICS OF THE GOLD-NICKEL SYSTEM

Gene F. Day and Ralph Hultgren Feb. 1963 7 p 14 refs Repr. from J. Phys. Chem., v. 66, 1962 p 1532-1534
(Contract DA-ARO(D)-31-124-G230)
(IER Reprint 110-62; Materials Science Series Contribution 146; AROD-3496-2)

The heats of formation of five gold-nickel alloys have been measured at 1150° K by liquid tin solution calorimetry. The results have been correlated with other thermodynamic data and the equilibrium diagram for the gold-nickel system. Free energy, heat, and entropy values have been tabulated for the solid alloys. For a 10-atom-percent nickel alloy, the enthalpy relative to room temperature has been measured to 1250° K for comparison with ΔC_p values in the literature. Lattice parameter and density measurements indicate that the vacancy concentration in the quenched alloys is not great, in contradiction to previously reported results. Author

N63-13057 California U., Berkeley

THERMODYNAMICS OF THE STRUCTURAL MODIFICATIONS OF AgZn

R. L. Orr and J. Rovel Feb. 1963 9 p 14 refs Repr. from Acta Met., v. 10, Oct. 1962 p 935-939
(Contract DA-ARO(D)-31-124-G230)
(IER Reprint 7-63; Materials Science Series Contribution-148; AROD-3496-1)

Heats of formation of the three structural modifications of AgZn, the equilibrium b.c.c. β and hexagonal ζ phases and the quenched metastable ordered b.c.c. β' phase, have been measured by means of liquid tin solution calorimetry. The bonding energies of the ζ and β' phases were found to be approximately equal, the heat of formation of β' being actually 50 calories more exothermic than that of the stable ζ phase at 324° K. The relative stability of the ζ phase is ascribed to its higher entropy resulting from the fact that it is only partially ordered. From an estimate of the entropy difference between the two phases the free energy of the ζ phase was calculated to be

only 190 cal/g atom less than that of the β' phase at 324° K. The results of the thermodynamic considerations have been correlated with previously reported structural data for the β and ζ phases. Differences in the nature of the ordering in the β and ζ phases have been analyzed, leading to conclusions which appear to contradict previously expressed views regarding the mechanism of the $\zeta \rightleftarrows \beta$ transformation. Author

N63-13058 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THE SPECTRAL ABSORPTION COEFFICIENT OF HEATED AIR Technical Report
D. R. Churchill, S. A. Hagstrom, J. D. Weisner, and B. H. Armstrong Nov. 1962 98 p 29 refs
(Contract DA-49-166-XZ-009)
(DASA-1348)

That portion of the line absorption coefficient for heated air which depends only on the molecular band systems, i.e., not on population numbers, has been calculated for each line in the frequency region of interest, with a total of over 150,000 lines tabulated on magnetic tape. With the results for the O_2 Schumann-Runge system, a preliminary transport calculation has been completed for a slab of molecular oxygen. The effect of line widths on transmission is illustrated, and average transmissions are given as a function of frequency. The present results are compared with those of a previous calculation. Author

N63-13067 Argonne National Lab., Ill.
A TABLE OF THERMODYNAMIC PROPERTIES OF HYDROGEN FOR TEMPERATURES FROM 100 TO 3000°K AND PRESSURES FROM 1 TO 50 ATMOSPHERES
Charles E. Cohn and Gerald H. Golden Jan. 1963 269 p
(Contract W-31-109-eng-38)
(ANL-6673)

A table of thermodynamic properties of gaseous hydrogen is presented, covering the temperature range from 100° to 3000° K and the pressure range from 1 to 50 atmospheres. The calculations have been done by means of a computer routine which has been described elsewhere. The table has entries for temperature at 10° increments for pressure at 1-atmosphere and at 5-atmosphere increments from 5 through 50 atmospheres, and for 25%, 50%, 75%, and 100% of the gas initially in the para state. The first of these latter values corresponds to normal hydrogen, whereas the remaining values apply to vapor from liquid which has been stored for varying lengths of time. For each entry, the table gives the density in gm/liter, the enthalpy in joules/gm, the entropy in joules/(gm)(°K) and the fraction of the gas molecules which are dissociated. Author

N63-13068 Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JANUARY 1963
Albert V. Crewe Feb. 15, 1963 61 p 7 refs
(Contract W-31-109-eng-38)
(ANL-6683)

Nuclear-reactor research covered the following: boiling water reactors, liquid-metal-cooled reactors, general reactor technology, advanced systems research and development; and nuclear safety. J.R.C.

N63-13076 France. Ministère de l'Air, Paris
CONTRIBUTION A L'ÉTUDE DE LA DÉTENTE DE L'AIR DANS UN RÉSERVOIR [CONTRIBUTION TO THE STUDY OF AIR EXPANSION IN A TANK]
Jean-Claude Bellet Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Nov.] 1962 83 p 21 refs In French
(*Its* Publications Scientifiques et Techniques No. 390) Available from SDIT, 2, Ave. de la Porte-d'Issy, Paris (15e)

Included in this investigation are: (1) a comparative analysis of the two principal diagrams (temperature and entropy) used in the study of gas expansion; (2) a description of an experimental apparatus designed for recording the variations of pressure, temperature, and specific volume of air during its expansion in a tank (capacity 20 to 40 liters, initial pressure from 50 kg/cm² to 150 kg/cm², discharge capacity between 25 m³/h to 250 m³/h). Analysis of results consists of a comparison between the hypothesis of isentropic and polytropic expansion $\left[\frac{T}{T_0} = \left(\frac{P}{P_0}\right)^n\right]$ and evaluation of the quantitative heat increases of the air. Practical conclusions are discussed. I.v.L.

N63-13094 Columbia Radiation Lab., New York, N.Y.
RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM Twelfth Quarterly Progress Report, Sept. 16, 1962 through Dec. 15, 1962
R. Novick et al Dec. 15, 1962 70 p refs
(Contracts DA-36-039-SC-7830 and DA-36-039-SC-90789)

Evidence has been found for the existence of the $(1s\ 2s\ 2p)^4 P_{5/2}$ metastable state of the lithium atom. This state decays by autoionization with a lifetime of about 10 μsec. In addition to its intrinsic interest, this state and similar states in other atoms warrant study because they may serve as useful sources of polarized electrons and ions. Final results are reported on the magnetic moment of O^{15}. Precise values for the zero field hyperfine intervals and the level crossing fields of 245 day Zn^{65} are reported. The spin, magnetic moment, and quadrupole moment of 43 day Cd^{115m} have been determined by optical double resonance. Theoretical calculations of the moments of the cadmium and zinc isotopes have been made on the basis of the configuration mixing model; these are compared with the experimental values. New precise values of the HDS molecular parameters have been deduced from the measurements reported previously. Initial results are reported on the optical maser spectroscopy program. In the cooperative radioastronomy program with the Naval Research Laboratory, it has been found that the 3200 mc/sec radiation from Saturn is linearly polarized and that the magnetic poles of Saturn appear to be located in the equatorial plane of the planet. Author

N63-13121 Michigan U. Radiation-Solid-State Physics Lab., Ann Arbor
MICROWAVE INTERACTIONS AT CRYSTAL DEFECT CENTERS Final Report
Chihiro Kikuchi, Robert Borcherts, Hossein Azarbayejani, Sophocles Karavelas, and Glenn Sherwood Jan. 1963 191 p 56 refs
(Contract AF 49(638)-987)
(Rept. 04275-2-F)

CONTENTS:
1. PROPERTIES OF RUBY AND OTHER SAPPHIRES C. Kikuchi and S. Karavelas p 17-62 16 refs (See N63-13122 07-25)
2. X-RAY PRODUCED V^{+2} IN SINGLE CRYSTALS OF ZINC AMMONIUM SULFATE – $ZnSO_4 (NH_4)_2 SO_4 . 6H_2O$ R. Borcherts p 65-106 19 refs (See N63-13123 07-23)
3. Mn^{+++}EPR RESULTS IN $A_{II}B_{VI}$ COMPOUNDS G. H. Azarbayejani p 109-175 19 refs (See N63-13124 07-25)
4. SOLID STATE INSTRUMENTATION G. G. Sherwood p 178-191 2 refs (See N63-13125 07-15)

N63-13123 Michigan U. Radiation-Solid-State Physics Lab., Ann Arbor
PART II. X-RAY PRODUCED V^{+2} FROM VO^{+2} IN SINGLE CRYSTALS OF ZINC AMMONIUM SULFATE-$ZnSO_4(NH_4)_2SO_4.6H_2O$
Robert Borcherts *In its* Microwave Interactions at Crystal Defect Centers Final Report Jan. 1963 p 65-106 19 refs (See N63-13121 07-23)

VO^{+2} and V^{+2} in single crystals of zinc ammonium sulfate, and X-ray irradiated VO^{+2} in single crystals of zinc ammonium sulfate, magnesium ammonium sulfate, and zinc potassium sulfate were investigated. Results indicate that upon X-ray irradiation of the single crystals containing VO^{+2} the X-ray, or subsequent energetic electron that it produces, breaks the VO bond, removing the oxygen from the VO^{+2} site and leaving V^{+2} behind. Since the V^{+2} produced by irradiation and the crystalline field surrounding it is identical (as far as electron-spin resonance measurements can determine) to that found in single crystals of "grown" V^{+2} in zinc ammonium sulfate, the oxygen must be at a distance so removed that the crystalline field is unaffected. Electron-spin resonance spectrum along the K_2 axis for the VO^{+2} crystal, the irradiated VO^{+2} crystal, and the V^{+2} crystal is presented. I.v.L.

N63-13134 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)

STUDIES ON THE ALTERNANT MOLECULAR ORBITAL METHOD. IV. GENERALIZATION OF THE METHOD TO STATES WITH DIFFERENT MULTIPLICITIES

Ruben Pauncz (Technion, Haifa, Israel) Aug. 1, 1962 29 p 9 refs
Presented to the Advanced Course of the Winter Institute in Quantum Chem. and Solid State Physics, Sanibel Island, Fla., Jan. 1962
(Sponsored by Swed. Nat. Sci. Research Council and U. S. Air Force)
(Preprint 82)

A general formulation of the alternant molecular orbital method, applicable to states of different multiplicities in systems with an even number of atoms, is presented. The treatment is formulated in such a way that the same integral sums appear in the energy expression for the states belonging to different multiplicities. The resultant energy expressions show a simple dependence on the mixing parameter λ. Application to cyclic systems shows that the best λ values decrease slowly with increasing multiplicity. Comparison with the configuration interaction treatment reveals that the AMO method corresponds to a restricted CI treatment, but it is capable of yielding a considerable part of the energy improvement obtained by the latter method.
Author

N63-13135 Watertown Arsenal Labs., Mass.

GEOMETRY OF HIDDEN DEFECTS DETERMINED BY ULTRASONIC PULSE ANALYSIS AND SPECTROSCOPY

Otto R. Gericke Dec. 1962 15 p
(WAL-TR 830.5/5)

A novel ultrasonic test method is described using ultrasonic signals which contain a broad band of frequencies, and, in analogy to optics, can therefore be considered as "white" ultrasonic pulses. The form and spectral energy distribution, or "color," of such ultrasonic pulses is influenced by the geometry of a defect from which they are reflected. Hence, an analysis of the defect echo yields information on the defect configuration. Author

N63-13140 Johns Hopkins U., Baltimore, Md.

Final Report, July 1, 1956-Dec. 31, 1961 [HIGH ENERGY PHYSICS] June 1962 14 p
(Contract AF 18(603)-143)
(AFOSR-2661)

A study of the properties of nuclear particles discovered in cosmic rays and at high-energy accelerations is summarized. The areas covered include photographic nuclear-emulsion and helium bubble-chamber studies. R.C.M.

N63-13144 Göttingen U. Physikalisches Inst. (W. Germany)

RESEARCH ON SOUND PROPAGATION IN SOUND-ABSORBENT DUCTS WITH SUPERIMPOSED AIR STREAMS, VOL. III [Final Report]

F. Mechel, P. Mertens, and W. Shilz Wright-Patterson AFB, Ohio, 6570th Aerospace Med. Res. Labs., Dec. 1962 114 p 7 refs
(Contract AF 61(052)-112)
(AMRL-TDR-62-140(111)) OTS: $2.50

In ducts coated with a spatially periodic arrangement of Helmholtz resonators, amplification of the acoustic signal propagating in the direction of the flow occurs under certain circumstances of signal frequency and flow velocity. This dependence of signal frequency of amplification on flow velocity is known already. The dependence of signal amplification on the dimensions and the shape of the resonators used is investigated. An important figure is the ratio of the neck width in the flow direction to the spacing of the resonators. In ducts coated with porous absorbers, the attenuation of the acoustic signal depends strongly on the flow velocity. The influence of the flow is in the opposite direction at low frequencies (wavelength great compared to duct diameter) and at high frequencies (wavelength comparable to duct diameter) where the acoustic energy concentrates near the duct axis ("acoustic ray formation"). Measurement of the cross-distribution of the acoustic field for high frequencies indicates two mutually opposite flow effects. For quantitative evaluation of flow effects on the attenuation constant in absorbing ducts, the wave equation is solved under the assumption of unidimensional flow and of flow-independent wall impedance. The resulting determining equation is approximated for both low and high frequencies. As long as the assumptions are realized, the approximate equations yield good agreement with measurement. The theory gives a clear insight in how, at high frequencies, the actual attenuation constant is a compromise between two concurring flow effects.
Author

N63-13148 Bureau of Mines. College Park Metallurgy Research Center, Md.

THERMAL EXPANSION OF THE OXIDES OF YTTRIUM, CERIUM, SAMARIUM, EUROPIUM, AND DYSPROSIUM

Roy L. Wilfong, Louis P. Domingues, LeRoy R. Furlong, and Joseph A. Finlayson 1963 30 p 18 refs
(BM-RI-6180)

The linear expansion of high-purity oxides of yttrium, cerium, samarium, europium, and dysprosium was determined by the interferometric method for the temperature range 25° to 1,000° C. Single-crystal magnesium oxide and single-crystal aluminum oxide were used as reference materials. The bulk density and crystal form of the nonreference materials also were determined. The coefficients of linear expansion in the range 25° to 1,000° C were found to be 8.10×10^{-6} for yttria, 12.10×10^{-6} for ceria, 10.81×10^{-6} for samaria (monoclinic), 10.35×10^{-6} for europia (monoclinic), and 8.13×10^{-6} for dysprosia, each given in centimeters per centimeter per degree Centigrade. A detailed investigation of the interferometric technique for measuring thermal expansion in this temperature range was made. The interferometer was found to be a precise tool but only when adequate precautions were taken. These precautions are described.
Author.

N63-13149 Bureau of Mines. Berkeley Thermodynamics Lab., Calif.

LOW-TEMPERATURE HEAT CAPACITIES AND ENTROPIES AT 298.15° K OF SODIUM DIMOLYBDATE AND SODIUM DITUNGSTATE

W. W. Weller and K. K. Kelley Aug. 1962 9 p 9 refs
(BM-RI-6191)

Heat-capacity measurements of sodium dimolybdate ($Na_2Mo_2O_7$) and sodium ditungstate ($Na_2W_2O_7$) were conducted over the temperature range from 51° to 298° K. The entropies of the two compounds at 298.15° K were calculated from the heat-capacity values and were used, in conjunction with other entropy data, to evaluate the entropies of formation of the compounds from their constituent elements and oxides. Author

N63-13177 Oslo U. Inst. of Theoretical Astrophysics, Blindern (Norway)

RESONANCE METHOD IN SCATTERING THEORY Institute Report No. 11

Egil A. Hylleraas Jan. 1963 18 p 2 refs
(Contract AF 61(052)-134)
(ARL-63-8)

The resonance method for solving scattering problems for particles in given potential fields on the basis of partial-wave method is applied to the one-dimensional problem. The method consists in treating some physical constant defining the strength of the potential as a variable eigenvalue parameter, keeping the energy of the particle fixed at a negative value. The method owes its efficiency to the fact that discrete eigenvalues are, as a rule, much easier to obtain by direct calculations than the scattering phase shifts. In particular, for higher eigenvalues much profit can be drawn from suitable asymptotic formulae. J.R.C.

N63-13190 France. Ministère de l'Air, Paris

RÉALISATION D'UN PÉRIODOGRAPHE OPTIQUE. APPLICATIONS A L'ÉTUDE DES FONCTIONS DE TRANSPARENCE THE REALIZATION OF AN OPTICAL PERIOD-GRAPH. APPLICATIONS TO THE STUDY OF THE FUNCTIONS OF TRANSPARENCY

Jean Ch. Viénot (Besançon U.) Paris, Service de Documentation et d'Information Technique de l' Aéronautique (SDIT), [Mar.] 1962 153 p 32 refs In French
(*Its* Publications Scientifique et Techniques N.T.-107)
Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

The optical transfer function of an aperture or several apertures of different types (optical photography and emulsion photography) is determined by the extent of the variation of the luminous flux carried through a modulated beam. Understanding of the optical transfer function of the different types of apertures necessitated the following studies: analysis of apertures according to the ascribed laws of transparency; studies of dissymetries and their effects in photographic processes; determination of the limit of the region of registered and separable spatial noise frequencies; and the evaluation of information directly useful to optical transmission.

Transl. by I.v.L.

N63-13192 Göttingen U. Physikalisches Inst. (W. Germany)

RESEARCH ON SOUND PROPAGATION IN SOUND-ABSORBENT DUCTS WITH SUPERIMPOSED AIR STREAMS, VOLUME II [Final] Technical Documentary Report

F. Mechel and W. Schilz Wright-Patterson AFB, Ohio, 6570th Aerospace Medical Research Labs., Dec. 1962 82 p 4 refs
(Contract AF 61(052)-112)
(AMRL-TDR-62-140 (II)) OTS: $2.25

The attenuation of sound in absorbing ducts with superimposed flow is shown to be dependent in a high degree on the direction of the flow and its velocity. The change of attenuation is caused by a convective variation of the acoustic wavelength, by a nonlinear variation of the characteristic constants of the absorber, and by a deformation of the wave fronts in the profile of the mean flow. These changes can be calculated and are in good agreement with the experimental results. In a duct coated with undamped Helmholtz resonators, the mechanism of sound amplification is based on the interaction between the sound wave and the turbulence. The conversion of kinetic flow energy into acoustic energy is performed by synchronization of turbulence. For appropriate values for flow velocity and signal frequency, a long-range stable wave of pseudosound takes place. Sound and pseudosound interact with one another at the necks of the resonators. Author

N63-13195 Los Alamos Scientific Lab., N. Mex.

BETA DECAYS AND DELAYED GAMMAS FROM FISSION FRAGMENTS

James Griffin Feb. 18, 1963 48 p 14 refs
(Contract W-7405-ENG-36)
(LA-2811) OTS: $1.25

A theoretical study is made of the gross behavior of beta decays following nuclear fission in times from 10^{-2} to 10 seconds. First, a simple model is formulated to describe the situation in terms of a few parameters. Then, the most uncertain of these parameters are chosen to fit the observed rate of delayed gamma emission (assumed proportional to the beta-decay rate) for the $U^{235}(n,f)$ process. The description is extended to other isotopes by assuming that they differ only by small shifts of their initial fragment distributions away from that appropriate to neutron-induced fission of U^{235}. The result is a theoretical summary of the presently available data which can be used in predictive extrapolation of that data to situations not yet studied experimentally. Author

N63-13199 Ames Lab., Iowa State U. of Science and Tech.

INJECTION OF ELECTRONS INTO ANNULAR MACHINES. I. THE DYNAMICS OF THE INJECTED BEAM AND THE CENTRAL-SHIFT CAPTURE-MECHANISM Research and Development Report

Luigi Gonella AEC Div. of Tech. Information, Oct. 1962 127 p 36 refs
(Contract W-7405-eng-82)
(IS-313) OTS: $2.50

A phenomenological description is given of the injection process in the high-current conditions normally used in conventional machines. The equilibrium conditions, where the space-charge forces are equal to the focusing forces, cannot be used to define a space-charge limit controlling the injection by a simple saturation effect. An equilibrium current density J_e is defined that is used to gage the effect of the local space charge on the dynamics of the beam leaving the injector. This is studied in a simple approximation, as a function of the initial current density and spread. The results are qualitatively generalized to realistic conditions. They leave the gun as a coherent beam and for some turns before the order of the motion is disrupted, the beam pulsates in area while its center oscillates about the capture orbit. Since the initial current density is usually larger than J_e, the beam expands and hits the donut wall during the first turn; a part is lost and the center of the surviving part is shifted toward the capture orbit, so that most of its electrons are captured. The details of the process are discussed for single-turn and multiturn injection; the results agree with the experimental evidence. Ways toward a possible increase of intensity are suggested. Author

N63-13200 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho

PHASE TRANSFORMATIONS IN CALCINATION OF NITRATES OF ALUMINUM, STAINLESS STEEL, AND NICHROME

H. J. Eding, M. L. Huggins, and A. G. Brown (Stanford Research Inst.) AEC National Reactor Testing Station, Dec. 28, 1962 70 p 21 refs
(Contract AT(10-1)-205)
(IDO-14601) OTS: $1.50

Earlier studies (IDO-14580) had shown that low concentrations of boric acid would inhibit the formation of alpha alumina in the fluidized calcination of aluminum nitrate wastes. Studies designed to determine the optimum concentration of boric acid and the relative effectiveness of phosphoric acid were performed by heating synthetic mixtures at moderate pressure, and showed that they were equally effective at the same molal concentration. Differential thermal analysis of mixtures showed that the boric acid reacted with alumina below 183° C. Extraction of boric acid from selected samples indicated that the boron was bonded (probably in a random manner, as in glasses) to the alumina rather than to sodium. Addition of fission products was studied, and no unusual effects were found. The transformation studies on calcination of stainless steel nitrates indicated that alpha iron oxide would be formed even with the addition of moderate amounts of additives such as boric acid, phosphoric acid, or aluminum nitrate, or combinations. Rare earths were the most effective additive. Similar studies on nichrome wastes indicated that nickel oxide (crystalline) would be formed even with additives. The

studies included heating of synthetic mixtures at moderate pressure, differential thermal analysis, and use of a laboratory fluidized calciner. Author

N63-13201 General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.

RADIATION EFFECTS IN BORIDES. PART II. FISSION SINTERING OF BORIDE POWDERS

E. W. Hoyt and D. L. Zimmerman Feb. 15, 1962 23 p 12 refs
(Contract AT(04-3)-189)
(GEAP-3743) OTS: $0.50

Post-irradiation examination is made of borides irradiated as powders by reactor radiation. It is found that interparticle welding or sintering in irradiated materials contains a fissionable isotope (U-235 or B-10). There is some evidence that nonfissionable materials, such as Al_2O_3, also sinter under the influence of ionizing radiation. Principal mechanisms of thermal sintering are postulated and include the following: bulk diffusion, plastic flow, vapor transport, and surface diffusion. During the post-irradiation examination of the borides, the samples, which had been irradiated as powders, sintered into firmly bonded bodies. This radiation sintering occurred at temperatures hundreds of degrees below that required to produce similar interparticle bonding by the application of heat alone. J.R.C.

N63-13208 Battelle Memorial Inst., Columbus, Ohio

INITIAL IRRADIATION EVALUATION OF EXPERIMENTAL Al_2O_3-COATED FUEL PARTICLES

Neil E. Miller, Robert L. Ritzman, Richard J. Burian, and Charles W. Townley Jan. 30, 1963 34 p 9 refs
(Contract W-7405-eng-92)
(BMI-1613) OTS: $0.75

The in-pile behavior of alumina-coated UO_2 particles has been studied at temperatures ranging from 100° to 1070° C and to fuel burnups of about 5 a/o of the U^{235}. At 1070° C the particles exhibited excellent integrity and showed essentially complete fission-product retention to 3 to 4 a/o burnup of the fuel. Similar exemplary behavior was not found at 100° C where samples failed rapidly, failure being essentially complete in just a few hours. Studies carried out at intermediate temperatures indicated that the low-temperature failure occurred only at temperatures below about 500° C. It was postulated that the failure was a result of radiation damage to the alumina coatings, caused by bombardment of the interior surface of the coatings with fission recoils, and that no failure occurred above 500° C because sufficient annealing of the damage above this temperature took place. The in-pile studies were performed on both unsupported particles and particles supported in graphite or carbon matrices. Specimen performance was also evaluated by postirradiation examinations including fission-gas-release measurements, determination of the fraction of exposed uranium, and visual and metallographic examinations. Author

N63-13211 Aeronutronic, Newport Beach, Calif.

INFRARED TRANSMISSION STUDIES. VOLUME II. THE INFRARED ABSORPTION OF WATER VAPOR Final Report

P. J. Wyatt, V. R. Stull, and G. N. Plass Sept. 20, 1962 248 p refs
(Contracts AF 04(695)-96 and AF 19(604)-7479)
(SSD-TDR-62-127, Vol. II)

The infrared absorption of water vapor has been calculated over a wide range of path length, pressure, and temperature from 1000 to 10,000 cm^{-1}. The results are presented in extensive tables which give the transmission over intervals of 2.5 cm^{-1} at wave numbers below 3400 cm^{-1}. The average transmission over intervals of 20, 50, and 100 cm^{-1} is given over the complete frequency range. The calculated data representing the intensity, position, and number of spectral lines in a given frequency interval is tabulated in a form which is useful for transmission calculations. All lines from all isotopic species having an intensity greater than 10^{-5} of the strongest line in an absorption region were included in the calculation. The quasi-random model for the representation of band spectra is discussed in detail. Among its features are the possibility of representing the absorption by a series of lines which are arranged neither at random nor in a regular way. Author

N63-13212 Language Service Bureau, Inc., Washington, D.C.

THEORY OF STABILITY OF MOTION

I. G. Malkin Oak Ridge, Tenn., AEC, Technical Information Service Extension Transl. of Teoriya Ustoichivosti Dvizheniya. Moscow-Leningrad, State Publishing House of Technical-Theoretical Lit., 1952 462 p 257 refs
(Contract AF(40-1)-2274)
(AEC-TR-3352) OTS: $4.75

A systematic exposition is given of Liapunov's theory of stability of motion and its methods to demonstrate their application to the solution of concrete practical problems. The presentation is constructed to facilitate study by readers with a basic mathematical background. The material is covered as follows: basic concepts and definitions; Liapunov's second method for stabilized motions; criterion of stability as a first approximation for stabilized motions; critical cases for stabilized motions; stability of periodic motions; and unstabilized motions. R.C.M.

N63-13217 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THERMODYNAMIC PROPERTIES OF CARBON-DIOXIDE AND NITROGEN MIXTURES BEHIND A NORMAL SHOCK WAVE

Henry T. Woodward Washington, NASA, Mar. 1963 28 p 7 refs
(NASA TN D-1553) OTS: $0.75

Thermodynamic properties of the gas in equilibrium behind normal shock waves in mixtures of carbon dioxide and nitrogen are calculated for resulting temperatures from 3000° to 8000° K at intervals of 1000° K and pressures of 1, 10, and 100 atmospheres. Equilibrium temperature, pressure, density, and component mole fractions are presented as functions of shock velocity and ambient pressure for an initial temperature of 300° K. Mixtures of 25-, 50-, and 75-percent N_2 by volume are considered. The amounts of NO, C, and CN which are formed could make a significant contribution to the electron density and the radiative heat flux potential. Author

N63-13225 National Bureau of Standards, Boulder, Colo.

CRYOGENIC RESEARCH AND DEVELOPMENT Eighth Progress Report to National Aeronautics and Space Administration for Period Ending Dec. 31, 1962

R. J. Corruccini et al Dec. 31, 1962 28 p refs
(NASA Order R-45)
(NBS-7641) OTS: $2.60 ph, $1.04 mf

This report on cryogenics covers the following: physical properties of hydrogen; cryogenic instrumentation; consultation and advisory services; compilation of thermophysical properties of cryogenic materials; and cooldown of cryogenic transfer lines. J.R.C.

N63-13228 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

LOW-PRESSURE MERCURY ARC FOR ULTRAVIOLET CALIBRATION

Charles B. Childs Repr. from Appl. Optics, v. 1, no. 6, Nov. 1962 p 711-716

A study was made of the visible-ultraviolet irradiance produced by a commercial low-pressure mercury arc operated by an accompanying power supply with a rated input of 115 volts a.c. The 2537 Å irradiance was 3.9 $\mu W/cm^2$ at one meter at a specified axial position in ambient air at 20° C. The 2537 Å irradiance changed less than 2% when power-supply input varied from 105 to 130 volts a.c., with environmental temperatures of 19.4° C and 26.8° C and ambient airflows of 11.2 and 14.7 cm/sec, respectively. Spectral analysis of

the lamp irradiance in the 1900-6000 Å range showed that 92% originated from the 2537 Å mercury resonance line while the remaining 8% is attributable to 12 other mercury lines. The intensities of 55 other spectral lines of negligible intensity in the investigated range are given relative to the intensity of the 2537 Å line. The experimental mean free path of electrons in mercury vapor at 1 mm of Hg and 273° K was $\sim 5 \times 10^{-3}$ cm whereas kinetic theory gave 6.7×10^{-3} cm. Author

N63-13231 General Dynamics Corp. General Atomic Div., San Diego, Calif.

CHARGE STATES OF RECOIL ATOMS Final Report, April 18, 1960 through December 31, 1962

V. A. J. Van Lint and R. Denson Feb. 8, 1963 38 p 14 refs
(Contract DA-04-495-ORD-1961)
(GA-3873; AROD-2496-1)

Measurements of the charge state of copper atoms having energies up to 50 kev, and an average energy of 29 kev, have been performed. The recoil atoms were prepared as the result of a (γ, n) reaction in copper target foils. The recoil atoms which escaped from a surface of the target foil were detected by observing their radioactivity in an adjacent pure aluminum catcher foil. The charge state and energy spectrum of the charged recoils were measured by applying various retarding voltages to the catcher foil. The experimental results indicate that approximately 55 percent of the recoil atoms are charged, and that these charged recoil atoms are found throughout the energy spectrum. Author

N63-13250 Oak Ridge National Lab., Tenn.

NUCLEON-MESON CASCADE CALCULATIONS: TRANSVERSE SHIELDING FOR A 45-Gev ELECTRON ACCELERATOR (PART II)

R. G. Alsmiller, Jr., F. S. Alsmiller, and J. E. Murphy Feb. 28, 1963 45 p 5 refs
(Contract W-7405-eng-26)
(ORNL-3365) OTS: $1.00

Nucleon-meson cascade calculations were carried out to obtain data for use in the design of the transverse shield for the proposed 45-Gev linear electron accelerator. The initial values assume that the cascade begins with an electron striking the walls of the copper accelerator tube. The electron-photon cascade results in photonucleons and photopions. Graphs of the photonucleon and photopion yields are given as a function of energy for the cases where $\theta = 80°$, 95°, and 60°. The neutron, proton, pion, and muon intensities as a function of energy and distance for these angles are given in tabular form. R.C.M.

N63-13277 Gottingen U. Physikalisches Inst. (W. Germany)

RESEARCH ON SOUND PROPAGATION IN SOUND-ABSORBENT DUCTS WITH SUPERIMPOSED AIR STREAMS. VOLUME I [Final] Report

F. Mechel Wright-Patterson AFB, Ohio, Biomedical Lab., Dec. 1962 97 p 19 refs
(Contract AF 61(052)-112)
(AMRL-TDR-62-140, vol. 1)

The possible effects of flow on airborne sound attenuation in ducts are discussed. The theoretical part results in a simple attenuation formula which considers the following: change of the wavelength due to convection of the sound field, change of the sound pressure at the wall caused by the flow profile,change of the characteristic absorber properties by nonlinear effects, and sound scattering by vortices. With porous absorbers, another effect is caused by the different curvature of the phase plane at the boundary of the absorber. Measurements with a porous absorber and with damped Helmholtz resonators show reduction of the attenuation for sound propagation in the direction of the flow and an increase of the attenuation for sound propagation against the flow. With the help of pseudosound in flow and of partial waves in ducts with a periodic boundary structure, the sound amplification found in ducts coated with reactive absorbers can be explained by analogy to traveling wave tube amplification phenomena. This analogy was confirmed by measurements on resonant absorbers. Author

N63-13282 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho

ORGANIC REACTOR TECHNOLOGY Quarterly Report July 1-September 30, 1962

J. R. Huffman, J. A. Mc Bride, and J. W. Dykes AEC National Reactor Testing Station, Jan. 18, 1963 113 p 30 refs
(Contract AT(10-1)-205)
(IDO-16830) OTS: $2.25

The fundamentals of radiolytic breakdown of aromatic compounds, film formation on fuel element surfaces, the selection of resistant coolants, and the reclamation of coolants were investigated. Results indicate that: (1) Radiolysis of simple aromatic mixtures of benzene and polyphenyls showed that approximately equal amounts of radicals were produced from isomeric polyphenyls but that they differed in their scavenging ability. Similarity between values found in the radiolytic work and with chemically generated radicals suggests a free radical mechanism for radiolysis. (2) The weight of film formed on fuel element surfaces increased exponentially with higher boiling fractions. (3) 1,1'-diimidazole is a possible candidate for a resistant coolant; however, difficulties have arisen in its production. (4) Catalytic hydrocracking is successful in the reclamation of coolants. I.v.L.

N63-13306 Aerojet-General Nucleonics, San Ramon, Calif.

ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM: HIGH TEMPERATURE IRRADIATION OF UO_2-BeO BODIES

J. H. Saling (Battelle Memorial Inst.) and G. W. Titus Jan. 1963 46 p 11 refs
(Contract AT(10-1)-880)
(IDO-28600) OTS: $1.00

As a part of the ML-1 reactor fuel evaluation program, UO_2-BeO bodies containing two UO_2 compositions, 70 and 80 wt% UO_2, were irradiated to a burnup equivalent to 8750 hours of ML-1 reactor operation (8.5% U-235). It was estimated that maximum cladding surface temperatures of 1710° F were attained during irradiation. Reference design burnup for the ML-1 is 9.7% U-235, in 10,000 hours of operation at maximum clad surface temperatures of 1750° F. Post-irradiation examination of the test specimens revealed that the cladding of one of the 80 wt% UO_2-BeO specimens had ruptured after severe swelling. All other specimens showed little external effect from the irradiation. Fission gas release from the fuel varied between 0.59 and 2.7% except for the failed specimen which released about 69%. Considerable change was observed in the microstructure of the irradiated specimens, although subsequent X-ray diffraction examination did not indicate serious damage to the crystal structure of either the BeO or UO_2. The data obtained from this experiment are in substantial agreement with that determined in irradiation experiments performed at other facilities. The performance of 70 wt% UO_2-BeO was considered to be suitable for use in the ML-1 reactor. Author

N63-13312 Bureau of Mines. Berkeley Thermodynamics Lab., Calif.

HEATS AND FREE ENERGIES OF FORMATION OF VANADATES OF LEAD AND MANGANESE

K. K. Kelley, L. H. Adami, and E. G. King 1963 13 p 15 refs
(BM-RI-6197)

The heats of formation of two lead vanadates ($Pb_2V_2O_7$ and $Pb_3V_2O_8$) and manganese vanadate (MnV_2O_6) were determined by hydrochloric acid solution calorimetry, supplementing previous Bureau of Mines measurements of the vanadates of calcium, magnesium, and sodium. Heat and free energy data for 11 vanadates were assembled on a common basis. The stability of comparable vanadates (with respect to the oxides) increases in the following order: magnesium, manganese, lead, calcium, sodium. Author

N63-13313 Bureau of Mines. Berkeley Thermodynamics Lab., Calif.

THERMODYNAMIC DATE FOR GALLIUM AND SCANDIUM SESQUIOXIDES

L. B. Pankratx and K. K. Kelley 1963 11 p 14 refs
(BM-RI-6198)

High-temperature heat-content values of gallium and scandium sesquioxides were measured over the temperature range from 298° to 1,800° K. The results fill gaps in the thermodynamic information for these compounds; no previous similar data existed. The heat-content values were combined with heats and entropies of formation to obtain free energies of formation of gallium and scandium sesquioxides to 2,000° K. The thermodynamic stabilities of the sesquioxides of aluminum, gallium, scandium, and yttrium were compared. Author

N63-13319 Oak Ridge National Lab., Tenn.

SPACE VEHICLE SHIELDING STUDIES. CALCULATIONS OF THE ATTENUATION OF A MODEL SOLAR FLARE AND MONOENERGETIC PROTON BEAMS BY ALUMINUM SHIELDS

R. G. Alsmiller, Jr., and J. E. Murphy Jan. 23, 1963 117 p 24 refs
(NASA Manned Spacecraft Center Purchase T-7632; W-7405-eng-26)
(ONRL-3317) OTS: $2.50

Using the straight-ahead approximation, nucleon-meson cascade calculations have been carried out for a typical proton flare spectrum incident on a shield and also for approximately monoenergetic incident proton beams. The shield material considered has approximately the properties of aluminum. The results from the monoenergetic beams may be used to obtain shielding information for any incident proton spectrum. Author

N63-13320 Rochester U., N.Y.

DESIGN OF A QUADRUPOLE CHANNEL

Stephen V. Pepper Dec. 4, 1962 11 p 3 refs Submitted for Publication
(Contract AT(30-1)-875)
(NYO-10251)

The calculation of design parameters of a quadrupole channel to contain an external particle accelerator beam is considered on the basis of the matrix method of calculating betatron oscillation amplitudes. The principal result is a relation between the physical parameters of the magnets and the acceptance solid angle of the system relative to the beam source. Author

N63-13321 Rochester U., N.Y.

A STUDY OF THE REACTION MECHANISM OF THE C^{13} (d,n)N^{14} and C^{13} (d,p)C^{14} REACTION BETWEEN 3.2 AND 4.1 MEV

V. K. Deshpande Dec. 17, 1962 27 p 18 refs Submitted for Publication
(Contract AT(30-1)-875)
(NYO-10252)

Angular distributions and excitation curves have been obtained for the C^{13}(d,n)N^{14} and C^{13}(d,p)C^{14} reactions between 3.2 and 4.1 Mev. Angular distributions of both protons and neutrons show a strong peak at about 25°, typical of stripping with l = 1 for the captured nucleon. The (d,n) distributions also show a secondary maximum of about 80° which does not show up in (d,p) distributions. The excitation curves are flat except for a weak resonant structure at 3.4 Mev. Plane wave Butler theory does not account for the secondary maximum of the (d,n) distributions, and it overestimates absolute cross sections for both reactions. The distorted wave calculation gives a satisfactory fit to the (d,p) distribution at all angles, but it predicts similar distributions for both (d,n) and (d,p) reactions, contrary to the experimental result. The compound nucleus formation does not seem to be an important participating mechanism. The possibility that the odd $P_{1/2}$ neutron of the C^{13} nucleus might be a participant in the (d,n) reaction is explored. The heavy particle stripping mechanism predicts angular distributions changing rapidly with energy, a feature not observed in the experiment. The angular distribution calculated on the basis of exchange stripping mechanism for C^{13}(d,n)N^{14} reaction has the feature of the secondary maximum. Although this calculation is made with the plane wave approximation, it gives some indication that the odd $P_{1/2}$ neutron in C^{13} may be a participant in the reaction. Author

N63-13322 Rochester U., N.Y.

IRREDUCIBLE REPRESENTATIONS OF GENERALIZED OSCILLATOR OPERATORS

T. F. Jordan, N. Mukunda, and S. V. Pepper [1962] 30 p 16 refs
(Contract AT(30-1)-875)
(NYO-10253)

All of the irreducible representations are found for a single pair of creation and annihilation operators which together with the symmetric or antisymmetric number operator satisfy the generalized commutation relation characteristic of para-Bose or para-Fermi field quantization. The procedure is simply to identify certain combinations of these three operators with the three generators of the three-dimensional rotation group in the para-Fermi case and with the three generators of the three-dimensional Lorentz group in the para-Bose case. The irreducible representations are then easily obtained by the usual raising and lowering operator techniques. The applicability of these techniques is demonstrated by a simple argument which shows that the commutation relations require that the generator to be diagonalized has a discrete spectrum. Author

N63-13323 Rochester U., N.Y.

QUANTUM ELECTRODYNAMICS WITHOUT ELECTROMAGNETIC FIELD

I. Bialynicki-Birula (Warsaw U.) Feb. 6, 1963 15 p 12 refs
(Contract AT(30-1)-875)
(NYO-10255)

It is shown that in a nonlinear Heisenberg-type theory a bound state appears which has all the properties of a neutral vector particle. From such a model all the results of standard electrodynamics follow in the limit of infinite bare coupling constant. The method used is that of Schwinger's external sources. Author

N63-13324 Rochester U., N.Y.

NEW SERIES FOR PHASE SHIFT IN POTENTIAL SCATTERING

S. Rosendorff and S. Tani (New York U.) Feb. 11, 1963 40 p 20 refs Submitted for Publication
(Contract AT(30-1)-875)
(NYO-10256)

A new series for the phase shift has been derived for the Schroedinger, Klein-Gordon, and Dirac equation. This series converges faster than the Born series for the tangent of the phase shift. This is so because the sum of the first n terms in the new series includes exactly all the terms up to the $2.(2^n - 1)$-th order in the Born series. Under the condition which is tantamount to that the phase shift cannot be larger than 63°, the series converges absolutely. At high energies the series can be analytically continued with respect to the strength of the potential beyond such a limit. It is shown that the high-energy limit of the phase shift is given by its first Born approximation and that the difference between even and noneven potentials is reflected in the respective phase shifts to all orders. Author

24 PHYSICS, PLASMA

Includes: fusion; and magnetohydrodynamics.

For related information see: 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N63-12933 Radio Corp. of America. RCA Labs., Princeton, N.J.
RESEARCH ON THE VOLUME RECOMBINATION OF CESIUM IONS Interim Engineering Report No. 1, For the Period Oct. 1, 1960-Mar. 31, 1962
P. V. Goedertier and J. M. Hammer Ft. Eustis, Va., Army Transportation Research Command, Nov. 1962 42 p 56 refs
(Contract DA-44-177-TC-694)
(TCREC-TR-62-82)

An apparatus to implement a new method of measuring radiative recombination, based on the passage of an ion beam through an electron cloud, has been constructed. Initial tests of the subcomponents and of the apparatus itself give some indication that the method will work. The method and the apparatus are described, and the implications of the initial measurements are discussed. Author

N63-12949 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE MAGNETIC FIELD OF A LINE CURRENT IN A TRANSVERSE RAREFIED PLASMA STREAM
Albert G. Munson Washington, NASA, Feb. 1963 22 p 10 refs
(NASA TN D-1551) OTS: $0.75

The steady-state flow of an infinitely conducting, rarefied, neutral plasma past a line current is considered. According to the Chapman-Ferraro theory, the plasma is confined to the exterior and the magnetic field to the interior of a cavity, the boundary of which is a thin current sheath. Within these restrictions the problem is solved exactly by a method similar to the hodograph method of incompressible fluid dynamics, and the magnetic field inside the cavity is presented. Results of approximate and exact solutions are compared. Author

N63-12961 Case Inst. of Tech., Cleveland, Ohio
MEASUREMENTS ON CURRENT SHEETS IN PLASMAS
O. K. Mawardi and M. Naraghi Oct. 1962 18 p 9 refs Submitted for Publication
(NASA Grant NsG-198-62)
(Tech. Rept. A-2) OTS: $1.60 ph, $0.80 mf

The acceleration of a gas undergoing ionization in a crossed electric-magnetic field leads to the formation of current sheets similar to those observed in coaxial plasma guns. The dynamics of such sheets is of great interest to workers in plasma physics in view of their application to controlled thermonuclear fusion experiments and to space propulsion. A detailed mapping of the magnetic field in the vicinity of a current sheet is described. Conventional small search coils are used for the detection of this field. From the configuration of this field an attempt is made to understand the processes taking place in the sheet. All of the experiments described in the paper are performed on a plasma coaxial gun of small aspect ratio. Author

N63-12963 Case Inst. of Tech., Cleveland, Ohio
GRAVITY-LIKE ELECTROSTATIC PLASMA WAVES IN INHOMOGENEOUS ELECTRIC FIELDS
F. Winterberg June 1962 26 p 3 refs Submitted for Publication
(NASA Grant NsG-198-62)
(Tech. Rept. A-9) OTS: $2.60 ph, $0.98 mf

The propagation of electrostatic waves in a perfectly conducting plasma is investigated in the linearized approximation of the equations of motion under the assumption of an unperturbed electric field $E = E(z)\,n$, where n is a unit vector along the z-axis. Wave-like solutions are studied which satisfy for the current density j the additional condition $\mathrm{div}\ j = 0$. Such solutions have a behavior quite analogous to gravity waves. Dispersion relations have been derived, including the more general case in which a magnetic field is present. Author

N63-12964 Case Inst. of Tech., Cleveland, Ohio
THE ANALYSIS OF A VORTEX TYPE MAGNETOHYDRODYNAMIC INDUCTION GENERATOR
L. L. Lengyel (Ph. D. Thesis) Oct. 1962 137 p 24 refs
(NASA Grant NsG-198-62)
(Tech. Rept. A-10) OTS: $10.50 ph, $4.31 mf

Consideration is given to the performance characteristics of an a.c. magnetohydrodynamic power generator. A rotating magnetic field is imposed on the vortex flow of an electrically conducting fluid, which is injected tangentially into an annulus formed by two nonconducting concentric cylinders and two nonconducting end plates. A perturbation technique is used to determine the two-dimensional velocity and three-dimensional electromagnetic field and current distributions. Finally, the generated power, the ohmic losses, the effective power, and the electrical efficiency of the converter system are calculated. Author

N63-12965 Case Inst. of Tech., Cleveland, Ohio
A PROBE INVESTIGATION OF HOT SEEDED GASES
John C. Handley (M. S. Thesis) Nov. 1962 108 p 50 refs
(NASA Grant NsG-198-62)
(Technical Report A-12) OTS: $9.10 ph, $3.44 mf

An oxygen-hydrogen combustion chamber and nozzle, into which potassium hydroxide was injected, was built in order to produce seeded plasmas of relatively simple and well-known molecular composition. A technique for propelling a simple probe through the nozzle was developed and was apparently quite successful. It was found that severe disturbances in the electrical properties of the seeded plasma flowing through the nozzle were caused by combustion instabilities inside the combustion chamber. Despite these disturbances, a number of conclusions were drawn regarding the behavior of a probe in a dense, high-velocity plasma, and also regarding the properties of the seeded plasma. For the probe, it was found that the current drawn in the supersonic region was very much greater than inside the combustion chamber. This was explained in terms of the thicker boundary layer surrounding the probe inside the combustion chamber, and the effect of electron attachment and recombination inside this boundary layer. For the plasma properties, it was concluded that the dominant negative charge carrier in the supersonic region was probably the hydroxyl ion. The recombination coefficient between the hydroxyl and sodium ions was probably of the order 10^{-8} cc/sec. Author

N63-12985 New York U. Courant Inst. of Mathematical Sciences, N.Y.
GRAVITATIONAL INSTABILITY AND ONE-COMPONENT PLASMA OSCILLATIONS
Richard L. Liboff Nov. 30, 1962 16 p 9 refs
(Contract AT(30-1)-1480)
(MF-33; WYO-9754)

A kinetic study is made of a system of neutral particles which interact under gravitational forces. The Jeans instability is recaptured in the limit of long wavelengths where the growth rate assumes characteristic maximum value. As the wavelength diminishes to a certain critical distance, the instability vanishes. This distance is consistent with thermal-gravitational estimates for the diameter of a star. Plasma oscillations are found in the central region of a one-component charged gas cloud. Author

N63-13047 California U., Livermore. Lawrence Radiation Lab.
INVERTED CASCADES IN NEUTRAL INJECTION SYSTEMS
John R. Hiskes Nov. 6, 1962 18 p 15 refs
(Contract W-7405-eng-48)
(UCRL-7115) OTS: $0.50

A process is described whereby the successive collisional excitation of the excited state distribution of an energetic neutral beam can result in the almost complete Lorentz ionization of the initial excited

state population. The development of the cascade may permit an exponential growth of the ion density in contemporary neutral-injection experiments for base pressures an order-of-magnitude higher than required for exponentiation by collisional ionization. Author

N63-13070 Rensselaer Polytechnic Inst. Plasma Research Lab., Troy, N.Y.

A 10 KILOGAUSS, AIR COOLED MAGNET FOR PLASMA RESEARCH Technical Report No. 6

J. E. Rudzki and E. H. Holt Jan. 1963 24 p 5 refs Submitted for Publication

(NASA Grant NsG-48-60)

OTS: $2.60 ph, $0.92 mf

A 10-kilogauss electromagnet with a working volume 20 cm. long and 15 cm. in diameter has been built for plasma research. A Helmholtz coil design uses a total of one hundred turns. A helix form of construction is built up from annulus-shaped copper discs which were slit and brazed together. Mica insulation was used. The coil has an air core. Power is supplied from a bank of wet cells. The coil draws 78 kw at 15 volts. Maximum operating time is one minute, which removes the need for cooling. Design and construction data are given. Author

N63-13126 International Atomic Energy Agency, Vienna (Austria)

NUCLEAR FUSION, 1962 SUPPLEMENT—PART I. JOURNAL OF PLASMA PHYSICS AND THERMONUCLEAR FUSION

1962 377 p refs Proceedings of the Conference on Plasma Physics and Controlled Nuclear Fusion Research, Sept. 4-9, 1961, Salzburg Texts in original language with English abstracts Sessions I, II, and IV (For Part 2 see N63-13127 07-24)

The Conference on Plasma Physics and Controlled Nuclear Fusion Research was held in Salzburg, Austria, on September 4 to September 9, 1961. More than 500 scientists, representing 29 nations and 6 international organizations, participated in the conference. The proceedings are published in three parts as a 1962 supplement to this journal. Part I contains the texts, in original language only, of all papers delivered in sessions I, II, and IV of the conference. Translations of abstracts of each paper (sessions I, II, and IV) are given and an author index is presented. The remainder of the proceedings is published in part 2, (sessions III, V, VI, and VIII) and in part 3, (sessions VII and IX). I.v.L.

N63-13127 International Atomic Energy Agency, Vienna (Austria)

NUCLEAR FUSION, 1962 SUPPLEMENT—PART 2. JOURNAL OF PLASMA PHYSICS AND THERMONUCLEAR FUSION

1962 444 p refs Proceedings of the Conference on Plasma Physics and Controlled Nuclear Fusion Research, Sept. 4-9, 1961, Salzburg Texts in original language with English abstracts Sessions III, V, VI, and VIII (For Part I see N63-13126 07-24)

N63-13129 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

DAMPING OF QUANTIZED LONGITUDINAL ELECTRON OSCILLATIONS IN A NONDEGENERATE PLASMA

James F. Morris Repr. from Phys. Fluids, v. 5, no. 11, Nov. 1962 p 1480-1481 5 refs

A new damping factor, obtained from the dispersion expression for longitudinal electron oscillations in a quantum thermal plasma, is presented. The factor is determined by considering the random-phase approximation above the degeneracy temperature and treating the electrons as a classical gas. The damping factor δ_q equals that of Landau (δ) multiplied by a function with an argument proportional to the plasma quantum divided by the electron thermal energy. Author

25 PHYSICS, SOLID-STATE

Includes: semiconductor theory; and masers.

For related information see: 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

N63-13028 General Electric Co. Missile and Space Vehicle Dept., Philadelphia, Pa.

DEVELOPMENT OF LOW TEMPERATURE DIELECTRIC COATINGS FOR ELECTRICAL CONDUCTORS Fourth Quarterly Report

K. N. Mathes July 16, 1962 44 p 4 refs

(NASA Contract NAS8-2442)

OTS: $4.60 ph, $1.52 mf

Low-temperature dielectric coatings are developed for electrical conductors. The polyimide-coated wire is believed to meet all of the electrical requirements under the test conditions specified except that the power factor at room temperature is in excess of 0.1%. The ML-coated wire, plus the aluminum phosphate felted asbestos overcoating is intended to provide an inorganic insulation with expected resistance to atomic radiation and to detonation under impact in liquid oxygen. Breakdown values of wires in vacuum are generally not as high as those obtained with immersion in liquid nitrogen. The d.c. resistance and the a.c. loss characteristics of all insulations seem to be markedly improved at liquid nitrogen temperature and tremendously improved at liquid helium temperature. Since the low electrical losses at cryogenic temperatures do not result in higher breakdown voltage, it must be postulated that breakdown failure is a mechanical or intrinsic fault rather than the thermal type. It is likely that heat aging may change the performance characteristics of some insulations subsequently exposed at cryogenic temperatures. J.R.C.

N63-13122 Michigan U. Radiation-Solid-State Physics Lab., Ann Arbor

PART I. PROPERTIES OF RUBY AND OTHER SAPPHIRES

Chihiro Kikuchi and Sophocles Karavelas *In its* Microwave Interactions at Crystal Defect Centers Final Report Jan. 1963 p 3-62 16 refs (See N63-13121 07-23)

A review of the properties of ruby and other sapphires encompasses: crystal structure; energy-level diagram; properties of other $3d^3$ ions; trigonal field and spin-orbit coupling; character table; the $3d^2$ configuration; and the $3d^5$ configuration. I.v.L.

N63-13124 Michigan U. Radiation-Solid-State Physics Lab., Ann Arbor

PART III. Mn^{++} EPR RESULTS IN A $_{II}B_{VI}$ COMPOUNDS

G. H. Azarbayejani *In its* Microwave Interactions at Crystal Defect Centers Final Report Jan. 1963 p 109-175 19 refs (See N63-13121 07-23)

Investigation of the cubic ground state splitting in $A_{II}B_{VI}$ compounds doped with Mn^{++} includes: (1) crystal preparation and doping with impurities of CdTe and ZnTe; (2) electron-spin resonance measurements; and (3) theoretical aspects which encompass the general Hamiltonian of Mn^{++}; spin Hamiltonian; crystalline field; hyperfine splitting; determination of $3a = {}^4\Gamma_4 - {}^2\Gamma_7$ parameters; and the determination of hyperfine splitting constant A'. I.v.L.

N63-13197 Armour Research Foundation, Chicago, Ill.

RADIATION EFFECTS ON SEMICONDUCTOR CATALYSTS [Final] Technical Documentary Report [January 1, 1961 to January 31, 1962]

H. C. Sosnovsky Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Oct. 1962 39 p 34 refs

(Contract AF 33(616)-7740)

(ARF-3190-6; ASD-TDR-62-233)

The effect of ion bombardment on carrier lifetime, photoconductivity, and surface structure of germanium (111) crystals was investigated after bombardment at voltages between 10 and 2000 v. It was found that the lifetime decreased significantly at bombarding voltages above 80 v and that the number of defects in the surface region increased simultaneously by several orders of magnitude. These defects are most likely dislocations and vacancy clusters. Less stable defects were introduced at very low bombarding voltages but these too were found to affect the electrical properties of the bombarded surfaces appreciably. Preliminary results of the effect of adsorbed gases on the properties of ion-bombarded surfaces, and the effect of neutron bombardment on the catalytic exchange of hydrogen with deuterium on etched surfaces are included. Author

N63-13210 Radio Corp. of America. RCA Labs., Princeton, N.J.
HIGH TEMPERATURE SEMICONDUCTOR RESEARCH Final Report, October 1, 1959-September 30, 1962
L. R. Weisberg David Sarnoff Research Center, Oct. 31, 1962 54 p 46 refs
(Contract AF 19(604)-6152)
(AFCRL-62-944)

The high-temperature semiconductor research was mainly materials-oriented rather than device-oriented. Of this work, roughly 70% was performed on GaAs, 20% on GaP, and 10% on GaAs-GaP alloys. This research has provided four primary contributions: discovery and explanation of the existence of large concentrations of lattice defects in GaAs; understanding and controlled preparation of high resistivity (semi-insulating) GaAs; delineation of the introduction and behavior of impurities in GaAs; and significant progress toward the preparation of large single crystals of GaP. Research on lattice defects in GaAs is described. A compilation of the deep energy levels found to date in GaAs is given. In addition, because of its importance in determining the properties of GaAs, the measurement technique of thermally stimulated currents is discussed. Author

N63-13278 France. Ministere de l'Air, Paris
ÉTUDE DE LA STRUCTURE DE BANDES DU TELLURE PAR LES PHÉNOMÈNES DE TRANSPORT [STUDY ON THE STRUCTURE OF TELLURIUM BANDS BY THE TRANSPORT PHENOMENON]
Claudette Rigaux Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Apr.] 1962 83 p 24 refs
In French
(Its Publications Scientifique et Techniques N.T.-109) Available from SDIT, 2, Ave. de la Porte-d'Issy, Paris (15e)

The galvanometric and thermoelectric properties of doped tellurium single crystals have been investigated at low temperatures (between 77° and 250° K). The following conclusions are drawn from the experimental results: (1) the points of constant energy of the valence band can be represented by a model having 12 ellipsoids whose parameters (principal effective mass and angular orientation) have been determined and related to a mixed (phonon and impurity) collision mode; and (2) the phenomena of double nullification of Hall and Seebeck effects is explained by the existence of two conduction bands separated by an environmental energy of 0.36 ev. M.P.G.

N63-13287 Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.
ELECTRON SPIN-LATTICE RELAXATION AT DEFECT SITES; E' CENTERS IN SYNTHETIC QUARTZ AT 3 KILOOERSTEDS Scientific Report No. 1
J. G. Castle, Jr., D. W. Feldman, P. G. Klemens, and R. A. Weeks Oct. 11, 1962 51 p 42 refs
(Contract AF 19(628)-1640)
(AFCRL-62-910)

Measurements of the spin-lattice relaxation time, T_1, by the inversion-recovery technique are reported for two paramagnetic centers in quartz over a wide temperature range. The data are interpreted in terms of cross-relaxation, direct processes, and Raman processes. The theory of spin-lattice relaxation is extended to account for the modification at a defect site to strain due to a lattice wave. If the characteristic frequency is sufficiently low compared to the Debye frequency, the Raman relaxation rate should vary as T^3 (or T^5) over a wide range of temperature, instead of the usual T^7 (or T^9) variation. Two characteristic frequencies are observed for each E' center; one frequency ($\approx 45°$ K) is associated with a proton near the E' center. A model for the E' center is proposed. Author

26 PROPELLANTS AND COMBUSTION

Includes: fuels; igniters; and oxidizers.

For related information see: 07 Chemistry; and 27 Propulsion.

N63-12843 Bell Aerosystems Co., Buffalo, N.Y.
DEVELOPMENT OF EXPULSION AND ORIENTATION SYSTEMS FOR ADVANCED LIQUID ROCKET PROPULSION SYSTEMS Phase I Progress Report for Period 1 June through 15 October 1962
D. Newman et al Edwards AFB, Calif., Rocket Research Labs., Dec. 1962 311 p 82 refs
(Contract AF 04(611)-8200)
(SSD-TDR-62-172)

Results of a study to determine the most feasible means of ensuring positive expulsion of liquid propellants under zero gravity conditions are presented. Various physical phenomena were evaluated for their effectiveness in constraining the propellant adjacent to the tank outlet. Among the unconventional methods studied were surface forces, electrical and magnetic fields, acoustical fields, and foaming plastics. Surface and electrical (dielectrophoretic) forces evolved as the most practical means of orienting propellants in the tank. The surface force method offers simplicity, good cycle life, and comparatively lower developmental costs. Author

N63-12956 Army Missile Command. Propulsion Lab., Redstone Arsenal, Ala.
THE EFFECTS OF RF ENERGY ON THE XM6 AND XM8 EBW SQUIBS
D. L. Thomson, J. W. Vann, and W. L. Strickland Jan. 15, 1963 12 p
(RK-TR-63-1)

The XM6 and XM8 emploding-bridgewire squibs were tested to determine their susceptibility to radiofrequency energy. In the tests, both types of squibs were fired with RF energy, using an impedance matching network to effect efficient transfer of power through a transmission line. The energy levels required for initiation were much higher than those required for conventional squibs. Author

N63-13007 Aerojet-General Corp. Chemical Products Div., Azusa, Calif.
PROTOTYPE PROPELLANT-TESTING SYSTEM. PHASES I AND II—FEASIBILITY AND PRELIMINARY DESIGN [Final Report, 14 May 1962-30 Nov. 1962]
R. C. Adrian and H. C. Edgington Edwards, Calif., AFSC Rocket Propulsion Labs., Feb. 1963 124 p 117 refs
(Contract AF 04(611)-8196)
(Rept. 2452; RTD-TDR-63-3)

The feasibility of constructing a test system for studying dynamic effects in liquid-propellant streams was examined, and a prototype system was designed that is acceptable for use with storable, corrosive, or cryogenic fuels and oxidizers. Recommendations are made for on-stream analyzers suitable for the monitoring of a wide range of physical and chemical properties of dynamic systems. A contaminant-addition system was designed to provide propellant of a known contamination level for subsequent tests. Author

N63-13025 Argonne National Lab., Ill.

SUMMARY OF INVESTIGATIONS UPON THE UO_2-NaK SLURRY AS A POTENTIAL REACTOR FUEL

R. D. Carlson and E. S. Sowa Nov. 1962 72 p 85 refs
(Contract W-31-109-eng-38)
(ANL-6644)

This report summarizes studies carried out with the UO_2-NaK slurry system to ascertain its potential properties as a fuel for advanced reactor systems. Included are the studies of the physical chemical properties of the slurry, the early loop investigations, in-pile studies, and the exploration of the engineering system behavior of the material. The studies under the program were relatively modest, but they did serve to demonstrate some of the attractive properties of the material as well as its limitations. Specifically, the dropout behavior was demonstrated in piping and tank systems in both conventional and specially designed systems. Hydraulic characteristics were demonstrated, and it was observed that a 10 v/o slurry was the maximum concentration that could conveniently be handled in conventional engineering systems. In-pile performance of the slurry was demonstrated and it was concluded that slurries do have potential for application in specialized, advanced systems. Author

N63-13034 Atomics International, Canoga Park, Calif.

PULSE HEATING OF MODIFIED ZIRCONIUM-URANIUM HYDRIDES

R. E. Taylor [1962] 28 p 5 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7736) OTS: $0.50

Fourteen samples of modified zirconium-uranium hydrides ($ZrU_{0.04}H_{1.8 \pm 0.1}$) were pulse heated to destruction. Data on power input, electrical resistivity, temperature, and hydrogen release during the 450-msec pulses are presented. Half of the samples were heated nonuniformly, due to internal flaws; two failed catastrophically; and five samples heated uniformly. Essentially all of the hydrogen was released from three of the latter samples. A phase change was observed at an average composition of $ZrU_{0.04}H_{1.40 \pm 0.02}$, and the specific heat was represented by $c_p = 0.0898 + 8.44 \times 10^{-5} t$ cal/g-° C from 25 to 850° C. Following the phase change, 49.2 ± 2.0 kcal were required to drive one mole of hydrogen from the fuel. Author

N63-13035 Liquid Propellant Information Agency, Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.

HYDROGEN-AIR CHEMICAL KINETIC CALCULATIONS IN SUPERSONIC FLOW

A. A. Westenberg Dec. 1962 48 p 16 refs
(CM-1028)

An IBM-7090 computer program has been used to study the ignition and combustion of H_2-air mixtures in a constant pressure supersonic flow combustor and the subsequent history of the combustion products as they pass through a divergent nozzle. The chemical kinetics is based on eight reversible elementary reactions involving H_2, H_2O, O_2, H, O, and OH which are believed to represent the actual kinetic behavior as nearly as is possible at present. No mixing effects are considered. Four cases are carried through the complete analysis (from combustion chamber inlet to nozzle exhaust) which cover a wide range of possible hypersonic flight inlet conditions. Calculated values of ignition delay time are shown to agree well with experimental shock tube results. The calculated delays are short enough so that this purely chemical effect should be no barrier to achieving combustors of practical length. Combustion chamber and nozzles (1-cm and 15-cm inlet radii) are evaluated in terms of various performance parameters. An additional set of calculations is discussed in which chamber inlet static temperature, pressure, and fuel-air ratio were separately varied to bring out the effect of these parameters on performance. Among other things, these results show for the case considered: (a) at constant fuel-air ratio and inlet temperature, increasing static pressure gives higher exit stream thrust per unit total mass flow I_s; (b) at constant fuel-air ratio and inlet pressure, increasing temperature gives higher I_s; and (c) at constant inlet temperature and pressure, increasing fuel-air ratio gives higher I_s. Author

N63-13041 Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.

POST-IRRADIATION EVALUATION OF A PLATE-TYPE UO_2 FUEL ELEMENT

H. G. Meieran Jan. 1963 79 p 5 refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-332) OTS: $2.00

The premature failure of fuel Element M22, which had six compartments of 0.100-inch-thick, 96% TD UO_2 + 6 w/o ZrO_2 fuel, has been attributed to the large irradiation-induced solid volume swelling of the UO_2 fuels. This volume swelling was the result of incomplete homogenization during fabrication of the mixed and sintered U^EO_2 and U^NO_2 fuels in Element M22. In addition, heavy hydriding of the nickel-free Zircaloy-2 cladding occurred in the relatively hot areas adjacent to the fuel and to a lesser extent at the external cladding surfaces. By postulation, hydrogen was apparently formed by the radiolytic decomposition of water entrapped between fuel and cladding after formation of the initial cladding defect, and was absorbed by the cladding so rapidly that it could not diffuse adequately down the thermal gradient to the cold side of the cladding. The corrosion behavior of the cladding was as expected and did not contribute to the hydriding. Analysis of the CR-X-3 loop operating history indicates that no abnormal conditions external to Element M22 existed in the loop other than uranium from inpile intentionally defected fuel elements. Author

N63-13071 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio

REACTIVITY OF METALS WITH LIQUID AND GASEOUS OXYGEN

J. D. Jackson, W. K. Boyd, and P. D. Miller Jan. 15, 1963
(Contract AF 33(616)-7747)
(DMIC-MEMO-163)

Of all the metals studied to date, titanium exhibits the greatest sensitivity to impact when immersed in LOX. Its sensitivity approaches that of many organic materials, such as greases and oils. Reactivity is observed in liquid oxygen and mixtures of liquid oxygen and liquid nitrogen at 20 ft-pounds until the LOX concentration is reduced to 30 percent. Titanium can be partially protected from reactivity in LOX under impact by certain protective coatings, provided the coatings are not broken. Protection is given by electroless copper and nickel, possibly aluminum, and to a lesser extent by Teflon and a fluoride-phosphate coating. Protection is also obtained by nitriding, which adds a protective film to the surface, and by annealing, which increases the thickness of the oxide film. Titanium exhibits no great reactivity in LOX when deformed by compression, by exposure of a fresh surface by machining or rupture, or by exposure of bulk titanium to high-pressure or high-velocity LOX. In gaseous oxygen, titanium is highly reactive when a freshly formed surface is exposed at even moderate pressures. When a titanium vessel containing LOX or gaseous oxygen is ruptured by a bullet, by a simulated micrometeoroid, or by other mechanical puncture, violent burning begins at almost 0 psig. If the vessel is not fractured by external impact, vibration, acoustic energy, thermal effects, or with slowly propagated cracks, such as fatigue cracks, no reactivity is noted. Of other metals

discussed, only zirconium shows similar reactions in oxygen. Stainless steels are found to exhibit almost no reactivity in oxygen under impact, rupture, explosive shock, or heating. Aluminum is similarly unreactive, but will ignite under conditions of high-explosive shock. Magnesium shows reactivity to explosive shock lying about midway between that of aluminum and titanium. For high-pressure oxygen systems, stainless steel and Monel were found to be satisfactory.
Author

N63-13081 Stanford Research Inst., Menlo Park, Calif.
A SURVEY AND EVALUATION OF HIGH ENERGY LIQUID CHEMICAL PROPULSION SYSTEMS. PART I: PROPELLANT SELECTION CRITERIA FOR SPACE MISSIONS Final Report, March 15, 1961 to October 15, 1962
James A. Mac Lead and P. Roger Gillette Nov. 1, 1962 85 p 23 refs
(NASA Contract NASr-38; SRI Proj. PRU-3652)
OTS: $8.10 ph, $2.75 mf

Results of a study are presented to develop a procedure for evaluating liquid propellants in order (a) to select the most appropriate propellant (from among those under development) for each of several applications on each of the various missions in the NASA program, or (b) to select new propellants (from among those being proposed) for initiation or continuation of research and development.
Author

N63-13082 Stanford Research Inst., Menlo Park, Calif.
A SURVEY AND EVALUATION OF HIGH ENERGY LIQUID CHEMICAL PROPULSION SYSTEMS. PART II: PREPARATION AND PROPERTIES OF OZONE FLUORIDE Final Report, Mar. 15, 1961 to Oct. 15, 1962
Adolph B. Amster, Joseph A. Neff, and A. J. Aitken Nov. 1, 1962 64 p 39 refs
(NASA Contract NASr-38)
OTS: $6.60 ph, $2.12 mf

Rocket engines which use liquid hydrogen and liquid oxygen are being developed for use in missiles for space exploration. The reliability of these engines would be improved by making the propellant combination hypergolic: Ozone fluoride, O_3F_2, when dissolved at very low concentrations in liquid oxygen reportedly accomplishes this end. This report contains a review of the properties of O_3F_2 and other fluorine-oxygen compounds. Also included are results of studies of O_3F_2 conducted at Stanford Research Institute. These studies have confirmed the synthesis and photochemical decomposition of O_3F_2. Results from both laboratory and engine ignition tests suggest conditions under which O_3F_2 renders the liquid system O_2-H_2 hypergolic. The report begins with a review of the chemical and physical properties of other compounds of oxygen with fluorine and concludes with suggestions for the additional research required to establish the utility and reliability of O_3F_2 as a hypergolic additive. In addition, information concerning safety and compatibility problems is included.
Author

N63-13109 Cornell Aeronautical Lab., Buffalo, N.Y.
COMBUSTION OF METALS
George H. Markstein Charlottesville, Va. U. School of Engineering and Applied Science, Nov. 1962 64 p 77 refs Presented at the 17th Annual Meeting and Space Flight Exposition, ARS, Los Angeles, Nov. 13-18, 1962
(Contract Nonr-3623(00); Proj. Squid)
(CAL-86-P)

Metal combustion problems are given a cursory examination. Current difficulties are the presence of combustion products with the fuel in the combustion zone, the upper limit on flame temperature of metal oxides imposed by the boiling point of the oxides, and the lack of reliable thermodynamic data required for equilibrium computations. Present trends and proposals for future research are presented for the ignition and burning of metals, combustion of metals in propellants and propulsion devices, reaction kinetics, and the radiation and spectra of metal flames.
A.R.B.

N63-13249 Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.
INVESTIGATION OF ADVANCED HIGH ENERGY SPACE STORABLE PROPELLANT SYSTEM [Final Report] June-November 1962
B. E. Dawson, A. F. Lum, and R. R. Schreib [1962] 118 p 25 refs
(NASA Contract NASw-449)
(RMD-5507-F) OTS: $9.60 ph, $3.74 mf

The feasibility of using an oxygen difluoride-diborane propellant combination for use in space applications was investigated. Results indicate that the OF_2-B_2H_6 propellant combination is feasible for space applications. High performance and hypergolic ignition under simulated altitude starting conditions were demonstrated. No unexpected problem areas were encountered in the experimental program attributable to the physical properties, material compatibility, or the handling and safety characteristics of either propellant. Further tests should be made to substantiate the vacuum operational cooling requirements of the propellant combination, as well as to demonstrate its scalability to thrust ranges suitable for space applications.
I.v.L.

27 PROPULSION

Includes: airbreathing, electric, liquid, nuclear, and solid propulsion.

For related information see: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N63-12886 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
NASA RESEARCH ON HEAVY-PARTICLE ELECTROSTATIC THRUSTORS
William R. Mickelsen N.Y., Inst. of the Aerospace Sciences, [1963] 16 p 19 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(IAS Paper-63-19) IAS: $0.50 members, $1.00 nonmembers

Thrustor inefficiency and thrustor operation at off-optimum specific impulse seriously decrease electric spacecraft performance. It appears that existing atomic-ion electrostatic thrustor designs will not have adequate efficiency at low specific impulse, but heavy-particle thrustors might have high efficiency in the entire specific impulse range of interest. The NASA research program on heavy-particle thrustors is described. Some preliminary data on heavy-molecule thrustors are shown, and some recent colloidal-particle thrustor work is discussed.
Author

N63-12896 Electro-Optical Systems, Inc., Pasadena, Calif.
TEST RESULTS FOR A CESIUM ELECTRON BOMBARDMENT ION MOTOR
R. C. Speiser, W. D. Kilpatrick, and G. R. Reid N.Y., Inst. of the Aerospace Sciences, [1963] 21 p 5 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(NASA Contract NAS8-2511)
(IAS Paper-63-75) IAS: $0.50 members, $1.00 nonmembers

Electron bombardment ion motors using cesium as an expellant have been tested and discharge and engine characteristics studied. Cathode configurations heated entirely by power delivered from the arc provided mass utilization efficiencies of 90 percent at 650 ev/ion. The engines achieved overall efficiencies of 70 to 80 percent at specific impulses of 6000 to 85000 seconds and thrust up to 10 mlb. Author

N63-12897 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SPACECRAFT PROPULSION REQUIREMENTS FOR LUNAR EXPLORATION MISSIONS
R. R. Breshears N.Y., Inst. of the Aerospace Sciences, [1963] 24 p 3 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(NASA Contract NAS5-916)
(IAS Paper-63-76) IAS: $0.50 members, $1.00 nonmembers

Presented in this paper are some of the spacecraft propulsion-system requirements for lunar-orbiting and -landing missions. Included are requirements imposed by flight path, accelerometer errors, altitude determination errors, and impulse errors. Major consideration was given to determining the effect on the spacecraft system of minimizing the requirements on the propulsion system. Of particular concern is minimizing the number of maneuvers, number of engines, and throttling requirements. For a lunar-orbiting mission it appears that a single fixed-thrust engine would be sufficient to satisfy all propulsion requirements. For a lunar landing employing descent from lunar orbit, a single engine with a throttling range as low as 3.5:1 appears able to perform all propulsion maneuvers. For lunar landings from lunar orbit, or direct lunar landings employing a fixed-thrust main descent engine, a separate landing engine with a throttling range as low as 2:1 appears acceptable. Author

N63-12907 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
TURBOJET PERFORMANCE AND OPERATION AT HIGH ALTITUDES WITH HYDROGEN AND JP-4 FUELS
W. A. Fleming, H. R. Kaufman, J. L. Harp, Jr., and L. J. Chelko Washington, NACA, Aug. 7, 1956 47 p 9 refs
(NACA RM E56E14) OTS: $4.60 ph, $1.61 mf (Declassified)

Two current turbojet engines were operated with gaseous-hydrogen and JP-4 fuels at very high altitudes and a simulated Mach number of 0.8. With gaseous hydrogen as the fuel, stable operation was obtained at altitudes up to the facility limit of about 90,000 feet, and the specific fuel consumption was only 40 percent of that with JP-4 fuel. With JP-4 as the fuel, combustion was unstable at altitudes above 60,000 to 65,000 feet, and blowout limits were reached at 75,000 to 80,000 feet. Overall performance, component efficiencies, and operating range were reduced considerably at very high altitudes with both fuels. Author

N63-12908 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab. Cleveland, Ohio
INVESTIGATION OF AN AFTERBURNING RAMJET USING GASEOUS HYDROGEN AS FUEL AT MACH NUMBER OF 3.0
Joseph F. Wasserbauer Washington, NACA, June 17, 1957 12 p 3 refs
(NACA RM E57C29) OTS: $1.60 ph, $0.80 mf (Declassified)

An experimental investigation was conducted in the Lewis 10- by 10-foot supersonic wind tunnel on a 16-inch ramjet that was equipped with an afterburner and used gaseous hydrogen for both the primary and afterburner fuels. The primary nozzle had a contraction ratio of 0.6 while the exit nozzle had a contraction ratio of 0.9. Data were obtained at a free-stream Mach number of 3.0 and zero angle of attack. The results of this investigation illustrate that, at a constant diffuser-exit Mach number, afterburner operation produces more than twice the thrust available without afterburning. Author

N63-12909 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
EXPLORATORY INVESTIGATION OF PERFORMANCE OF EXPERIMENTAL FUEL-RICH HYDROGEN COMBUSTION SYSTEM
Arthur L. Smith and Jack S. Grobman Washington, NACA, June 25, 1958 43 p 6 refs
(NACA RM E58C19a) OTS: $4.60 ph, $1.49 mf (Declassified)

An exploratory investigation was conducted to determine the performance characteristics of a fuel-rich hydrogen combustor; in addition, the performance of an afterburner operating with the fuel-rich exhaust mixture was evaluated. Four experimental combustors with a burning length of 18 inches were operated over a range of equivalence ratio from 7 to 26 at nominal fuel flows of 100 and 200 pounds per hour, inlet-air temperature of 80° F, and inlet pressures near 30 inches of mercury absolute. Two afterburner flame-holder configurations with a burning length of 36 inches were investigated over an equivalence-ratio range from 0.2 to 1 at inlet pressures near atmospheric. Author

N63-12931 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EROSION RESISTANCE AND FAILURE MECHANISMS OF SEVERAL NOZZLE MATERIALS IN A SMALL SOLID-PROPELLANT ROCKET ENGINE
Robert A. Signorelli and James R. Johnston Washington, NASA, 49 p 16 refs
(NASA TN D-1658) OTS: $1.25

A small-scale end-burning solid-propellant rocket-engine facility was constructed, and an investigation was conducted to study uncooled rocket-nozzle insert materials under carefully controlled test conditions. Relative performance and metallurgical failure mechanisms were determined for 12 nozzle materials, including refractory metals, graphites, cermets, reinforced plastics, and a ceramic. A nonaluminized propellant, Arcite 368, which has a theoretical flame temperature of 4700° F was used. The engine was designed to operate at a chamber pressure of 1000 pounds per square inch for 30 seconds with a nozzle-throat diameter of 0.289 inch. With the exception of molybdenum, all of the materials eroded to some degree. In general, the cermet and ceramic materials eroded very little (1 to 2 mils), tungsten and ZT graphite eroded moderately (5 to 9.5 mils), and the molded graphites and the 40-percent-resin phenolic-refrasil-composite material eroded extensively (up to 30.5 mils). The 20-percent-resin phenolic-refrasil and the phenolic-graphite materials eroded drastically (up to 54 mils), while complete failure occurred with phenolic-nylon material. The cermet and ceramic nozzles cracked extensively both radially and axially as a result of thermal stresses. Oxidation is believed to be the primary mechanism by which material was removed from the tungsten nozzle. Material removal from the graphite nozzles is attributed to oxidation coupled with mechanical erosion. Temperature measurements made with molybdenum and graphite nozzles indicated that the maximum throat-surface temperatures were slightly less than 3000° F, which is considerably below the 4700° F flame temperature. A technique for propellant burning-surface modification was developed involving internal ballistic formulas, which permits the systematic variation of engine chamber pressure. Author

N63-13193 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab. Cleveland, Ohio
AN ANALYSIS OF A NUCLEAR POWERED SUPERCRITICAL-WATER CYCLE FOR AIRCRAFT PROPULSION
Irving M. Karp Washington, NACA [1952] 76 p 9 refs
(NACA RM E53D29) OTS: $2.00

An analysis to indicate the feasibility of the supercritical water compressor jet cycle for nuclear-powered aircraft is presented. Performance values of the cycle are given for a range of design-point engine operating conditions at a flight Mach number of 1.5 and altitudes of 50,000, 40,000, and 30,000 feet, and at a flight Mach

number of 0.9 and an altitude of 40,000 feet. It is shown that the cycle is one requiring low compressor pressure ratios and one developing low thrust per unit airflow; consequently, it requires very high airflow rates and very large engine and exchanger frontal areas.
Author

N63-13218 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

TWO-DIMENSIONAL CRITICALITY CALCULATIONS OF GASEOUS-CORE CYLINDRICAL-CAVITY REACTORS

Robert E. Hyland, Robert G. Ragsdale, and Eugene J. Gunn Washington, NASA, Mar. 1963 29 p 10 refs
(NASA TN D-1575) OTS: $0.75

The critical mass of a cylindrical, gaseous-core cavity reactor system was computed with a four-group, two-dimensional diffusion code. Uranium 235 and plutonium 239 were considered as fuels. Moderator materials investigated were deuterium oxide (at 70° F) and graphite (at 70° and 5300° F). The study was conducted in two parts; the first part considered the effect on critical mass of variable fuel-region radius in a fixed-size cavity, and the second part pertained to specific effects for one particular configuration. The fuel region can be reduced to a radius of 0.20 to 0.33 of the cavity radius with little or no increase in critical mass. For fuel- to cavity-radius ratios from 0.20 to 1.0 and a graphite moderator at 5300° F, plutonium 239 requires about one-third of the critical mass of a uranium 235 fueled system. A hole (simulating an exhaust nozzle) through one end of the reflector-moderator region resulted in an increase in critical mass of 5 percent. The hydrogen gas, which in nuclear-rocket application would exist between the fuel and moderator regions, was found to have a negligible effect on critical mass. The critical mass is relatively independent of fuel-region temperature and can be computed by evaluating all thermal values at the moderator temperature.
Author

28 SPACE RADIATION

Includes: cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts.

For related information see: 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

N63-12880 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SOLAR RADIATION MONITORING

John C. Lindsay N.Y., Inst. of the Aerospace Sciences [1963] 8 p 9 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(IAS Paper-63-2) IAS: $0.50 members, $1.00 nonmembers

The successful launching of the first Orbiting Solar Observatory opened a new era in the study and monitoring of solar electromagnetic radiations. A reasonable degree of continuity across the ultraviolet, X- and gamma-ray spectral regions can now be achieved. The characteristics of the spacecraft that made this performance possible were the ability of the spacecraft to point instruments accurately at the sun, the ability to carry a large experimental payload (approximately 187 pounds of the total 456-pound spacecraft), a circular orbit below most of the radiation belt, and a tape recorder data storage system that supplied practically complete orbit coverage. Grazing incidence spectrometer and the X-ray ion chamber experiments have shown that the vacuum ultraviolet and X-ray radiations arise from different phenomena; i.e., the quiet sun, plage groups, "permanent coronal condensations", probably "sporadic condensations" and flares. It has also been shown that the time periods associated with data from these phenomena vary from a fraction of a second for the "sporadic condensation" to about fourteen days for the plage group crossing the solar disk.
I.v.L.

N63-12881 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SOLAR COSMIC RAYS

Frank B. Mc Donald N.Y., Inst. of the Aerospace Sciences [1963] 7 p 14 refs Presented at the IAS 31st Annual Meeting, N.Y., Jan. 21-23, 1963
(IAS Paper-63-3) IAS: $0.50 members, $1.00 nonmembers

Some of the pertinent properties of solar cosmic ray events are summarized. These include size vs. frequency of occurrence, propagation characteristics, and charge and energy spectra. The November 12 and November 15, 1961, events are regarded as possibly typical of the great events, and their complete time history is presented.
Author

N63-13045 Massachusetts Inst. of Tech. Lab. of Nuclear Science, Cambridge

GEOMAGNETICALLY TRAPPED PROTONS WITH ENERGIES GREATER THAN 350 MEV

Gordon Garmire (Ph. D. Thesis) [1962] 38 p 22 refs Submitted for Publication
(NASA Contract NASw-37)
OTS: $3.60 ph, $1.34 mf

The intensity and pitch-angle distribution of geomagnetically trapped protons with energies greater than 350 Mev have been determined by data received from a Cerenkov detector on board Explorer XI. An analysis of the data reveals that the contours of constant counting rate rise more rapidly in altitude with increasing latitude than do the contours at a threshold energy of 43 Mev. The scale height of the high-energy protons along a magnetic field line is found to be significantly greater than the scale height of the lower energy protons. The first of these results is consistent with a breakdown of the transverse adiabatic invariant J, which tends to steepen the proton energy spectrum with increasing geomagnetic latitude and altitude, assuming cosmic ray albedo neutrons to be the source of these protons. The assumptions concerning the breakdown of the invariance of J are justified through detailed numerical calculations of proton trajectories in both a dipole magnetic field and the Finch and Leaten approximation to the geomagnetic field. The second result is not consistent with the cutoff energy dependence obtained by trajectory calculations and the approximate constancy of the neutron albedo injection coefficient along a magnetic field line. The average atmospheric density $\overline{\rho}$, and energy losses (dE/dt), along a magnetic field line as a function of energy has been investigated. It is found that the variations of the scale heights of $\overline{\rho}$ and $\overline{(dE/dt)}$ are much less than the observed variation of the scale height of the radiation as a function of energy.
Author

N63-13096 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EARTH-REFLECTED SOLAR RADIATION INCIDENT UPON SPHERICAL SATELLITES IN GENERAL ELLIPTICAL ORBITS

F. G. Cunningham Washington, NASA, Feb. 1963 440 p 3 refs
(NASA TN D-1472) OTS: $6.00

A calculation is given for the earth-reflected solar radiation incident upon spherical satellites of unit cross-sectional area, in general elliptical orbits. The equations have been left in integral form, but have been machine integrated. The results are presented in tabular form for an extensive number of orbits, the incident energy P_{SE} (in milliwatts/cm^2) being given as a function of the azimuthal angle η of the satellite's position in orbit, measured from perigee. In addition, the orbital average of the incident radiation is calculated and

entered at the bottom of each table. The model used assumes: (1) that the earth can be replaced by a sphere of radius equal to its mean radius, 6,367.5 km; (2) that the potential of the earth varies strictly as 1/r; (3) that the mean solar constant is equal to 1.395×10^4 erg/cm^2-sec; and (4) that the mean albedo of the earth is equal to 0.34. Author

N63-13102 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE ANOMALOUS COMPONENT OF LOW-ENERGY GEOMAGNETICALLY TRAPPED PROTONS

A. M. Lenchek Washington, NASA, Feb. 1963 25 p 27 refs Previously processed as reprint. For abstract see N62-14269 12-12 (NASA TN D-1679) OTS: $0.75

N63-13103 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NEUTRONS IN SPACE

Wilmot N. Hess Washington, NASA, Feb. 1963 11 p 14 refs (NASA TN D-1696) OTS: $0.50

The various neutron sources in the solar system are discussed. Because of the neutrons' half-life, very few neutrons come into the solar system from outside. Cosmic rays interacting with the atmosphere or surface of the planets are the major neutron source near the planets. Studies of the neutron energy spectrum can give some information about the chemical composition of the planets. The sun is a source of neutrons from several processes. Thermonuclear burn in the corona and leakage from the burning cone do not seem to be important sources, but a significant number of neutrons may result from high-energy protons accelerated in flares on the sun. Author

N63-13167 Yerkes Observatory, Williams Bay, Wis.

FLUORESCENT SCATTERING IN PLANETARY ATMOSPHERES. II. COUPLING AMONG TRANSITIONS Research Paper No. 5

Yousef Sobouti Repr. from Astrophys. J., v. 135, no. 3, 1962 p 938-954 8 refs Previously processed as a preprint; for abstract see N62-11299 05-28
(NASA Grant NsG-118-61)

N63-13271 RIAS, Baltimore, Md.

NEUTRON MEASUREMENTS OUTSIDE THE EARTH'S ATMOSPHERE Final Report

L. Witten and J. P. Martin Jan. 1963 42 p 11 refs
(Contract AF 19(604)-7244)
(AFCRL-63-214)

A pair of neutron counting systems was carried on a ballistic flight path on a pod flown piggy back on an Atlas rocket on December 19, 1961, from Cape Canaveral. One system detected the fast neutron flux while the other detected slow neutron density. Measurements of albedo neutrons were made between 480-km and 1000-km altitude. The pod entered the trapped radiation belt in the vicinity of 1000-km altitude and 27° North geomagnetic latitude. The albedo neutron results from both systems are compared with the flux calculations of Hess, Canfield, and Lingenfelter. The flux data are compared with the work of Hess and Starnes. The density data are compared with the measurements of Reidy, Haymes, and Korff. A low-altitude increase in the density count rate suggests that some low energy trapped protons are found beginning at a lower altitude than the higher energy trapped protons. The flux of neutrons produced by radiation belt protons incident on the pod was determined to be about 700 neutrons/(cm^2 sec). This flux was estimated to be equivalent to a dose rate in tissue of 0.10 rems/hr. On the basis of proton flux measurements made in the radiation belt by Freden and White, a calculation was made of the tissue dosage which would have been received in the same environment directly from protons. The total dose calculated amounted to 2.78 rems/hr. Author

N63-13295 Iowa State U., Iowa City

ASYMPTOTIC CONES OF ACCEPTANCE AND THEIR USE IN THE STUDY OF THE DAILY VARIATION OF COSMIC RADIATION

U. R. Rao, K. G. Mc Cracken (MIT) and D. Venkatesan Repr. from J. Geophys. Research, v. 68, no. 2, Jan. 15, 1963 p 345-369 26 refs
(NASA Contract NASw-17 and Contract AT(30-1)-2098)

The dependence of the counting rate of a cosmic ray detector on the asymptotic directions of approach of the primary cosmic radiation is discussed. By means of a simulation of the geomagnetic field that uses spherical harmonics up to the sixth degree, and an arbitrary anisotropy in the primary cosmic radiation, a method for calculating the time variations in the counting rate of a cosmic ray detector is developed. Resolving the arbitrary anisotropy as a Fourier series in longitude, the amplitude and phases of the diurnal (24-hourly) and semidiurnal (12-hourly) components of the daily variation are calculated for a number of stations. No simple relationship is observed between the phases and the latitudes and longitudes, geographic or geomagnetic. Moreover, the theoretical calculations point out that a difference of more than five hours between the diurnal phases at two different places could arise purely from the known geomagnetic configuration. A study of the time-averaged diurnal component of the daily variation experimentally observed by 22 neutron monitprs during the International Geophysical Year (1957-1958) reveals good agreement with the theoretical calculations and lead to the following conclusions: (1) The results are consistent with an anisotropy that is independent of rigidity in the range 1 to 200 bv, the exponent of the power law which fits the data being 0.0 ± 0.05. (2) The anisotropy varies as the cosine of the asymptotic latitude and has a maximum in the direction 85° to the east of the earth-sun line. (3) The maximum amplitude of the average anisotropy is 4×10^{-3} times the average cosmic ray flux. Author

N63-13317 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.

SOLAR PROTONS AND MAGNETIC STORMS IN JULY 1961

B. J. O'Brien (Iowa State U.), G. F. Pieper, A. J. Zmuda, and C. O. Bostrom Repr. from J. Geophys. Research, v. 67, no. 13, Dec. 1962 p 4959-4981 55 refs
(NASA Grant NsG-233-62; Contracts NOrd-7368 and N9onr-93803)

The State University of Iowa's satellite Injun 1 (1961α_1) was launched at 0422 UT on June 29, 1961, and is in an orbit of 67° inclination with apogee 998 km and perigee 881 km. Among the Injun instruments are silicon p-n junction detectors sensitive to protons with energy between 1 and 15 Mev, and a Geiger counter sensitive to protons of energy above 40 Mev. These units detected solar protons during the period of considerable solar activity extending from July 11 to 28, an epoch containing twelve flares of class 2 or 3 and six major magnetic storms that can be divided into four distinct solar proton events. In this period the proton intensity varied widely, with a maximum unidirectional flux of 33,000 particles/cm^2 sec ster for 1- to 15-Mev protons occurring during the storm of 1115 UT, July 13, and a maximum omnidirectional flux of 900 particles/cm^2 sec for protons of energy above 40 Mev in the storm of 1121 UT July 18. In general, the energy spectrum varied from storm to storm and within a single storm. The temporal and spatial characteristics of the solar proton flux are correlated with details of geomagnetic storms and other solar-terrestrial phenomena such as polar-cap absorption. Some 1- to 15-Mev protons leak out of the main solar stream and enter the geomagnetic field many hours before the onset of a magnetic storm. These particles are observed only on magnetic shells of L with values between 4.8 and 6.1 earth radii, the range corresponding to the undisturbed geomagnetic cutoffs. A large influx of 1- to 15-Mev protons occurs during the last part of the initial phase of the storm and during the early part of the main phase, indicating their previous containment in the storm-producing plasma. A marked equatorial shift of the cutoff latitude occurs during the main phase of the storm. A sharp decrease in the flux in the main phase is followed by a slower exponential decay with a relaxation time of about one day for the 1- to 15-Mev particles. This decay begins after the peak of the main phase and extends through the recovery period of the storm, during

which the geomagnetic cutoff gradually returns to its prestorm value. The possibility that the 1- to 15-Mev particles are geomagnetically trapped during the exponential decay is discussed. Considerable fluxes of protons with energy above 40 Mev were observed during only one of the four solar proton events reported. The storm-time cutoffs of these protons occurred at L values lower than the corresponding cutoffs observed with the 1- to 15-Mev protons. These observations and those reported for similar events by other workers are compared in detail. An overall picture for such events is proposed. Author

29 SPACE SCIENCES

Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

For space biology see: 16 Life Sciences.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N63-12893 National Aeronautics and Space Administration, Washington, D.C.

ASTRONOMICAL ASPECTS OF THE EMERGENCE OF INTELLIGENCE

Su-Shu Huang and R. H. Wilson, Jr. N.Y., Inst. of the Aerospace Sciences [1963] 9 p 3 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963

(IAS Paper-63-48) IAS: $0.50 members, $1.00 nonmembers

Included in the discussion of the astronomical background which makes possible the emergence and development of intelligence in the universe are: (1) stellar populations and life occurrence; (2) criteria of the life supporting ability of a star; and (3) qualifications of habitable planets. I.v.L.

N63-12894 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE ACTION OF A HYPERSONIC JET ON A DUST LAYER

Leonard Roberts N.Y., Inst. of the Aerospace Sciences, [1963] 28 p 11 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963

(IAS PAPER-63-50) IAS: $0.50 members, $1.00 nonmembers

The paper defines a theoretical model to describe the erosion and subsequent transport of dust in the vicinity of a spacecraft landing on the moon. Available experimental information is examined and a more complete description of the exhaust-jet—dust-layer interaction is established. Particular attention is paid to three important phases of the problem: (1) the gas dynamics of the exhaust, (2) the mechanics of the surface erosion, and (3) visibility through the dust cloud. It is shown that the Mach number and Reynolds number of the exhaust flow, together with certain dust parameters, determine the character of the erosion. The shape of the crater caused by this erosion is calculated and shown to be in qualitative agreement with the experimental results. The extent of the dust cloud and visibility through the cloud are shown to depend on the size of the particles and the location of the vehicle above the surface. Author

N63-12900 Lockheed Missiles and Space Co., Palo Alto, Calif.

PROJECTS FOR EARLY MANNED INTERPLANETARY FLIGHT

Rollin W. Gillespie, Robert V. Raqsac, and Stanley Ross N.Y., Inst. of the Aerospace Sciences, [1963] 12 p 5 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963

(NASA Contracts NAS8-5024 and NAS8-2469)

(IAS Paper-63-84) IAS: $0.50 members, $1.00 nonmembers

Prospects and requirements for manned interplanetary flights to Mars and Venus during the first half of the 1970's are discussed. Mass requirements and mission durations are presented for single- or multi-planet flybys as well as for short orbiting capture missions. Vehicle technology of the advanced Apollo period has been assumed. Major emphasis has been placed on the desire for a limited planetary exploration program which will not seriously compete with the national lunar program for either funding resources or development effort. Alternative calculations are performed using both conservative and sophisticated subsystem capability assumptions to assess, in a coarse sense, the areas of maximum sensitivity to opposition period, trip duration, and major subsystem choice. Author

N63-12901 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

THE JPL TRAJECTORY SYSTEM

A. L. Laxdal and D. B. Holdridge N. Y. Inst. of the Aerospace Sciences, [1963] 20 p 3 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963

(NASA Contract NAS7-100)

(IAS Paper-63-85) IAS: $0.50 members, $1.00 nonmembers

Computer programs for trajectory and orbit determinations used in space mission design are described; and the trajectory monitor system which places the constraints on the trajectory and orbit programs is discussed. Since mission constraints are not directly related to the physical constraints implied by the equations of motion, they are checked by powered flight and space trajectory programs. As a first step toward automating trajectory design, a new system is being devised that will be independent of the programs operating under it. M.P.G.

N63-12922 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

REVIEW OF TECHNIQUES FOR MEASURING ROCK AND SOIL STRENGTH PROPERTIES AT THE SURFACE OF THE MOON

H. Carl Thorman N. Y., Soc. of Automotive Engineers [1963] 8 p 11 refs Repr. from Automotive Eng. Cong., Soc. of Automotive Engineers, Inc., Jan. 1963 Presented at the Automotive Engineering Congress, Detroit, Jan. 14-18, 1963

(NASA Contract NAS7-100)

(JPL-TR-32-374; SAE Paper-632C)

Among the various instruments which have been developed for performing post-landing experiments on the lunar surface from an unmanned spacecraft are several that provide means for observing how the lunar material responds to applied stresses. These include: penetration-hardness gages, soil-mechanics test apparatus, a subsurface-sampling rock drill, and a surface-sample collector. The design and operating features and the range of application of each of these four devices are reviewed in this paper. Author

N63-12928 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A SATELLITE ORBIT COMPUTATION PROGRAM FOR IZSAK'S SECOND-ORDER SOLUTION OF VINTI'S DYNAMICAL PROBLEM

Raymond V. Borchers Washington, NASA, Feb. 1963 37 p 8 refs (NASA TN D-1539) OTS: $1.00

This report extends the results of Vinti and Izsak and presents a computational procedure designed specifically for Izsak's second-order solution of Vinti's dynamical problem. With this procedure, the coordinates and velocity of an unretarded satellite can be obtained from a knowledge of its initial conditions r and v. In this procedure, the derivation is given for the complete set of six canonical constants from initial conditions. Three of these have been determined by Vinti and the remaining three by the author. All six of them are assumed known in Izsak's solution. This report includes an adaption of a Newton-Raphson iteration scheme specifically designed to solve a certain system of nonlinear equations introduced by Vinti for the purpose of numerically factoring a certain quartic equation. The solution by this method can be used instead of certain infinite series

to obtain Izsak's elements a and e. An example is included to illustrate how these elements may be obtained by the Newton-Raphson method. The derivation of exact expressions are given for the components of velocity in Vinti's accurate intermediary satellite orbit using Izsak's orbital elements. The derivation is one of the necessary steps in comparing such a method with others. Author

N63-12929 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE LUNAR ORIGIN OF TEKTITES

Dean R. Chapman and Howard K. Larson Washington, NASA, Feb. 1963 66 p 92 refs Presented at the 13th International Astronautical Congress, Varna, Bulgaria, Sept. 23-29, 1962
(NASA TN D-1556) OTS: $1.75

Recent research results from the discipline of atmosphere entry aerodynamics have been applied to the study of tektites, especially those found in Australia. Hypervelocity ablation experiments with tektite glass have reproduced in the laboratory the same surface sculpture patterns, the same geometric relationships, the same systematic alteration in internal striae, and the same types of coiled circumferential flanges as those found on the Australian tektites. The overall evidence establishes that the australites are objects which have entered the earth's atmosphere as individual pieces of rigid glass and and have been shaped by severe aerodynamic heating. Experiments have been conducted on molten glass ejected into the atmosphere with various viscosities and velocities. The results demonstrate that the configurations commonly formed by the action of aerodynamic pressures on fluid glass do not resemble the australite primary shapes. These experiments also show that the dominantly spheroidal forms of the primary australites were formed in an environment where the atmospheric density was many orders of magnitude less than that at the earth's surface. These results contradict the hypotheses that the australites originated from either the earth, or the other atmosphere-shrouded planets. Author

N63-12932 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PERIODIC ORBITS FOR MOON PROBES

Su-Shu Huang Washington, NASA, Feb. 1963 8 p 4 refs
(NASA TN D-1701) OTS: $0.50

A general discussion is presented on the broadening of scope, purpose, and, consequently, technique of celestial mechanics as a result of the space age. The discussion is focused on the time scale of the objects being studied. In order to differentiate from the more rigorous part of classical celestial mechanics, the name Space Mechanics is suggested to cover this field of study, which is empirical in purpose and numerical in approach. In the sense of Space Mechanics, some periodic orbits that enclose both the two finite bodies have been investigated within the framework of the restricted three-body problem. This represents only the first step in looking for orbits that will permit a moon-probing vehicle to make periodic encounters with the moon on its other side. Two families of periodic orbits have been found, one stable, one unstable, in the orbital plane of the hypothetical moon. Such periodic orbits also have been sought outside the orbital plane. Although a periodic orbit has been obtained numerically, it does not enclose the moon. Author

N63-13111 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A CISLUNAR ORBIT (IMP)

Barbara E. Shute Repr. from Astron. J., v. 67, no. 5, June 1962 1 p

The orbital changes of a proposed cislunar satellite are investigated. Under the disturbing influence of the moon, the eccentricity changes from 0.95 to 0.85 in one year, and the inclination (to the equator) moves from 33° to 48°, i.e., a change of 15° with respect to the equator or 25° with respect to the plane of the ecliptic. The case quoted assumes a ratio of semimajor axes of satellite-to-moon equivalent for a satellite period of about 6 days. Inclusion of the earth's oblateness and solar perturbations does not give significantly different results. J.R.C.

N63-13151 National Aeronautics and Space Administration. Washington, D.C.

MARINER II MICROWAVE AND INFRARED RADIOMETER RESULTS News Release No. 63-36-1

Feb. 26, 1963 12 p

The microwave and infrared radiometer observations of Venus by Mariner II are described and the results of a preliminary analysis of the data and their implications are discussed. The microwave radiometer scanned the surface of Venus at wavelengths of 13.5 and 19 mm. The data obtained from the microwave radiometer will be compared to infrared emission data at 8.4 and 10.4 micron wavelengths. Preliminary results indicate a surface temperature of near 800°F, a cloud layer temperature of about -30° F, and a cold spot in the cloud layer over the Southern Hemisphere. R.C.M.

N63-13152 National Aeronautics and Space Administration, Washington, D.C.

MARINER II COSMIC DUST EXPERIMENT News Release No. 63-36-3

Feb. 26, 1963 1 p

The cosmic dust experiment on Mariner II was designed to measure the flux of interplanetary dust particles between the Earth and Venus. The system was capable of detecting dust particles with masses as low as 1.3×10^{-10} gm (about one trillionth of a pound), according to NASA. Over 1700 hours of reduced data have been received. During this time two dust particle impacts on the sensor plate were recorded. The dust particle flux indicated by this measurement is approximately four orders of magnitude less than that observed near the Earth from similar experiments on satellites. Both of the above events occurred in deep space, and no impacts were recorded in the vicinity of Venus. Author

N63-13168 Chicago U., Ill.

UPPER ATMOSPHERES OF THE PLANETS Research Paper No. 8

Joseph W. Chamberlain (Yerkes Observatory) Repr. from Astrophys. J., v. 136, no. 2, 1962 p 582-593 20 refs
(NASA Grant NsG-118-61)

Most of our knowledge of the earth's upper atmosphere is obtained from experiments *in situ* or remote observations that offer fairly direct interpretations. For the other planets, neither approach is as yet possible; so indirect, theoretical procedures are required to construct models of their atmospheres. Herein the wide variety of basic physical processes governing the structure of a planetary high atmosphere are set forth, with a view toward obtaining "deductive models"—i.e., models derived theoretically when only the chemical composition and temperature of the lower atmosphere and the incident solar flux are specified (in addition to various physical and astronomical constants). The procedures are applied to Mars, whose lower and middle atmosphere is already partially understood from earlier work, notably that of R. Goody. The uncertainties involved at various stages in the construction of such a model are emphasized, as are the major differences in physical processes and atmospheric characteristics between Mars and the Earth. The most significant result is that the CO that must be in the upper atmosphere of Mars should serve as an effective thermostat, keeping the temperature at the escape level (1500 km) from exceeding about 1100° K. This is cool enough for Mars to retain atomic oxygen. Were it not for CO cooling, the upper atmosphere of Mars would be so extensive and form such an effective thermal insulation between the upper ionosphere and the heat sink at the mesopause that the temperature would exceed 2000° K. The lifetime for the escape of

oxygen is estimated at 10^9 years. The mesopause is determined by CO_2 radiation. Near the mesopause, CO_2 should become dissociated and the free O atoms form a thin layer of O_2; this effect has no analogy on Earth. The model ionosphere has considerably smaller densities of ionization than comparable regions in the Earth's atmosphere. The *E* region is split into two distinct portions, with X-rays forming the higher one (E_2) and ultraviolet light ionizing O_2 near the mesopause (E_1). The Martian analog to the terrestrial F_2 region may not develop a very high electron density, and the entire ionosphere should be depleted at night. Author

N63-13179 Yerkes Observatory, Williams Bay, Wisc.
FLUORESCENT SCATTERING IN PLANETARY ATMOSPHERES. I. BASIC PLANETARY CONSIDERATIONS Research Paper No. 4
Joseph W. Chamberlain and Yousef Sobouti Repr. from Astrophys. J., v. 135, no. 3, 1962 p 925-937 13 refs Previously processed as a preprint; for abstract see N62-11298 05-28
(NASA Grant NsG-118-61)

Resonance scattering, fluorescence, and pure absorption are considered as a mechanisms governing the daytime ultraviolet spectrum of a planet observed from above. It is assumed throughout that continuous absorption prevents any sunlight from being reflected by the ground (or cloud surface) and that the scattered continuum is weak compared with scattering in spectral lines. These considerations are appropriate to the ultraviolet, when ozone (or some other substance) is strongly absorbing in the high atmosphere. Such a spectrum is qualitatively different from a reflected Fraunhofer spectrum; this scattered light constitutes a daytime airglow of emission lines. To aid interpretation of such spectra, in terms of atomic and molecular relative abundances, several alternative models of line formation are investigated. Author

N63-13194 National Aeronautics and Space Administration, Washington, D.C.
FIELDS AND PARTICLES EXPERIMENTS ON MARINER II News Release No. 63-36-2
Feb. 26, 1963 12 p

The fields and particles sensors which were carried on Mariner II are described, and some significant data relayed by these sensors during the 129 days before loss of radio contact with Mariner is reviewed. The sensors included three magnetometers, three cosmic ray detectors, a cosmic ray ionization chamber, and a probe of solar plasma flux. The data on the nature of the interplanetary medium indicate that: (1) Solar gas continuously flows out from the Sun, although the velocity and intensity of the flow vary widely. (2) Venus rotates very slowly, and has a magnetosphere considerably smaller than the Earth's. (3) The flux of galactic cosmic remains fairly constant and is independent of the distance from the Sun. (4) Solar cosmic rays were detected by the omnidirectional counter on only one occasion, and the ionizing radiation dose was only about 3 roentgens for the entire four-month mission. (5) The unidirectional counter recorded eight solar bursts, including the October 23 event. The quantities and intensities of particles recorded during this mission are summarized. M.P.G.

N63-13273 College of William and Mary. Plasma Physics Lab., Williamsburg, Va.
CONSIDERATIONS OF THE MOTION OF A SMALL BODY IN THE VICINITY OF THE STABLE LIBRATION POINTS OF THE EARTH-MOON SYSTEM
William H. Michael, Jr. (M. A. Thesis) May 1962 97 p 12 refs

An analysis is performed to determine the properties of the motion of a small body in the vicinity of the stable libration points of the earth-moon system. On the basis of a first-order analysis of the equations of motion of the restricted three-body problem, an explicit solution is obtained for the position and velocity components of the motion as a function of the initial conditions. The results of the explicit solution lead to a rather complete determination of the properties of the motion as a function of the initial conditions, including: the position in orbit and the velocity components as a function of time, the properties of the component elliptical motions which comprise the resultant motion, the existence of periodic elliptical orbits through proper choice of initial conditions, and the limits of the motion. The analytical results are compared with results obtained by numerical integration of the equations of motion on a high-speed digital computer; the comparisons are good even for rather large excursions from the stable libration points. Author

30 SPACE VEHICLES

Includes: launch vehicle—spacecraft combinations; operating problems; and stability and control.

For manned space capsules, satellites, and space probes see: 32 Space Vehicles (Spacecraft).

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For related information see: 04 Aircraft; 08 Communication; and 22 Navigation and Guidance.

N63-12920 Aerospace Corp. Engineering Div., El Segundo, Calif.
MISSILE DESIGN FOR THE EFFECTS OF WINDS ALOFT
D. C. Bakeman Sept. 13, 1962 45 p 10 refs
(Contract AF 04(695)-69)
(TDR 69(211)TN-1; DCAS-TDR-62-190)

A major problem in the design of large booster missiles is the proper consideration of the effects from winds aloft. Since wind magnitude and direction are statistical in nature, the problem can only be solved by the use of statistical techniques. This report suggests that the design requirement be a given probability of failure or launch delay due to winds aloft, or an optimization between cost (in terms of weight, schedules, etc.) and the probability of failure or launch delay. A methodology is then presented, along with pertinent background information and discussion, for designing to any of those requirements. Also presented is a procedure for a prelaunch wind check in which wind-effects magnitudes are predicted for a flight. Author

N63-13040 Army Missile Command. Structures and Mechanics Lab., Redstone Arsenal, Ala.
TORQUE REQUIREMENTS OF AN IN-FLIGHT SPIN MECHANISM FOR A PRESCRIBED MISSILE ROTATIONAL VELOCITY
J. S. Bennett, K. N. Letson, and O. G. Wilkerson Nov. 12, 1962 28 p 7 refs
(RS-TR-62-6)

A method has been developed to calculate the torque required to spin a small missile to a specified rotational velocity. The origin of the torque forces is assumed to be a mechanical fixture which utilizes the missile motor exhaust and, therefore, operates as an inflight spin mechanism. The essential missile parameters are discussed and incorporated in a mathematical treatment which results in algebraic formulas for the calculation of torque. Author

N63-13059 Weapons Research Establishment (Australia)
THE AERO-ELASTIC DIVERGENCE OF SLENDER MULTI-STAGE TEST VEHICLES
K. D. Thomson Nov. 1962 34 p 5 refs
(HSA-93)

A simple theory is presented for determining whether slender, flexible, multistage missiles are likely to fail in flight by aeroelastic divergence. Although the theory gives conservative results, it has been found useful in explaining the failure of some missiles fired at Woomera and in providing a design criterion for other missiles which have flown safely. Author

N63-13188 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF THE EFFECTS OF BANK ANGLE, BANKING DURATION, AND TRAJECTORY POSITION OF INITIAL BANKING ON THE LATERAL AND LONGITUDINAL RANGES OF A HYPERSONIC GLOBAL REENTRY VEHICLE

Gene W. Sparrow Washington, NASA, Mar. 1963 25 p 2 refs (NASA TN D-1617) OTS: $0.75

An investigation has been made to determine the effect of banking position, bank angle, and banking duration on the lateral and longitudinal ranges of a hypersonic lifting reentry vehicle of global-range capability entering the atmosphere of a rotating oblate earth. Two schemes for controlling the angle of attack are used. Results indicate that banking the vehicle during the first half of a global-range reentry results in relatively large losses of longitudinal range without any appreciable gain in lateral range. In addition, it is found that lateral range can be obtained with less loss of longitudinal range if the scheme of using a small bank angle and an extended banking duration are used. A lift scheme which allows the angle of attack to increase during banking so that the vertical force does not decrease is not found to be as satisfactory as the constant angle-of-attack lift scheme because of relatively large losses of longitudinal range and reduced lateral-range capability. Author

N63-13301 Hughes Aircraft Co., Culver City, Calif.

TORQUES AND ATTITUDE SENSING IN SPIN-STABILIZED SYNCHRONOUS SATELLITES

Donald D. Williams [1962] 28 p 5 refs Presented at the American Astronautical Society, Goddard Memorial Symp., Washington, D.C., Mar. 16-17, 1962

Torques and attitude sensing in spin-stabilized synchronous satellites were investigated. Results indicate that: (1) Disturbances in the satellite spin axis attitude and spin rate in the synchronous orbit are essentially negligible; furthermore, control can be exercised over the attitude throughout the life of the satellite. (2) Complete velocity control in orbit is possible with fewer components in a spinning spacecraft than in a nonspinning one, and precise determination of the attitude is possible. (3) Key portions of the spacecraft may be despun if necessary, in some cases with less complication than if three-axis attitude control were substituted. (4) A constant torque acting over a time interval will produce certain angular displacements of two spacecrafts, if one is spinning and the other is nonspinning, and if they are of roughly similar size and weight. Under these circumstances, the angular displacement of the nonspinning spacecraft will be of the order of magnitude of the displacement of the spinning one, multiplied by the angle in radians through which the spinning craft rotates about its axis during the time interval. I.v.L.

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes: boosters; clustered rockets; and multistage rockets.

For propulsion engines see: 27 Propulsion.

For launch vehicle - spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-13158 Air Force Special Weapons Center. Test Directorate, Kirtland AFB, N. Mex.

USERS GUIDE TO PAYLOAD PLANNING FOR THE SLV-1B SPACE PROBE

Albert L. Haley and James H. Raddin Jan. 1963 97 p refs (SLV-1B-3)

This report reviews the considerations presented to an experimenter in considering or using the SLV-1B as a launching vehicle. Included are discussion of payload weights, apogees, environments, volumes, launch facilities, documentation, suggested schedules, and applicable agencies in the SLV-1B program. The SLV-1B is a relatively low-cost high-performance space probe, used principally for conducting relatively lightweight experiments in the region beyond 10,000 n.m. or for conducting preliminary test flights for satellite and deep space missions. The SLV-1B program utilizes and all-USAF planning, procuring, documenting, technical consulting, and launching organization. Author

N63-13163 National Aeronautics and Space Administration. Washington, D.C.

NASA'S MOST RELIABLE BOOSTER: DELTA News Release No. 63-40

Mar. 1, 1963 5 p

Because of a string of 15 successful missions, beginning with the launch of Echo I, NASA's Delta vehicle is considered to be its most successful launch unit. Although originally conceived as an interim booster, Delta will continue to play an important part in the U.S. space program; two new assignments include boosting the S-6 Atmospheric Satellite and the Interplanetary Monitoring Probe into orbit. M.P.G.

32 SPACE VEHICLES (SPACECRAFT)

Includes: manned space capsules; satellites; and space probes.

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For Launch vehicle—spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-12890 National Aeronautics and Space Administration, Washington, D.C.

PROBLEMS IN THE DESIGN OF UNMANNED SPACECRAFT FOR PLANETARY AND INTERPLANETARY EXPLORATION

James R. Miles, Sr. N. Y., Inst. of the Aerospace Sciences, [1963] 19 p Presented at the IAS 31st Annual Meeting, New York, Jan. 21-23, 1963

(IAS Paper-63-36) IAS: $0.50 members, $1.00 nonmembers

Problems in the design of spacecraft for interplanetary journeys, for making scientific observations enroute and at the destinations, are discussed in relation to the present technology and advances needed. Topics mentioned include: biological sterilization and its effects upon spacecraft hardware; midcourse maneuvers; capsule ejection, entry, landing, and deployment; power requirements, thermal control, and communications. Author

N63-12892 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

AN ORBITAL LAUNCH FACILITY (OLF)

George von Tiesenhausen N. Y., Inst. of the Aerospace Sciences, [1963] 16 p Presented at the IAS 31st Annual Meeting, New York, Jan. 21-23, 1963
(IAS Paper 63-43) IAS: $0.50 members, $1.00 nonmembers

There will exist, at the end of this decade, a requirement for orbital launch facilities capable of performing repair, checkout, and launch operations for space vehicles. It should be capable of servicing a variety of different vehicle classes, and when not functioning as an OLF, be capable of use as a scientific laboratory. Around these requirements, a simple and straightforward facility concept is developed, derived from present-day technology. Design and performance criteria are given, together with a conservative estimate on weights of the equipment required and power requirements. The major engineering problems involved are explained and a number of solutions are given. A conceptual approach is presented on an evolutionary orbital launch facility, together with a scientific laboratory. The compatibility of the OLF with available ground launch facilities and launch vehicles is shown. Author

N63-12899 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
MEASUREMENT OF PITCH DAMPING AT LARGE ANGLES OF OSCILLATION FOR PROPOSED MARS ATMOSPHERE-ENTRY VEHICLES
Bain Dayman, Jr., Duane A. Nelson, and Peter Jaffe N. Y., Inst. of the Aerospace Sciencies, [1963] 20 p 14 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963
(NASA Contract NAS7-100)
(IAS Paper-63-79) IAS: $0.50 members, $1.00 nonmembers

The particular aerodynamic, weight, reliability, and packaging requirements for a Mariner vehicle proposed for entry into the atmosphere of Mars suggest a high-drag body of revolution with length about equal to the maximum diameter. Even for the case of initial rearward entry, forward orientation with low oscillation amplitude of this vehicle during the heating pulse and just prior to parachute deployment must be accomplished passively, that is, without the need of any activating control devices. As six-degree-of-freedom atmosphere-entry studies indicate the large effect of very small amounts of pitch damping on the envelope of the angle-of-attack oscillation at the time of parachute deployment, it is necessary to determine accurately the pitch damping of such a proposed vehicle up to large angles of oscillation. The purpose of this paper is to discuss the two wind-tunnel methods being developed to accomplish this objective, namely, "frictionless" gas-bearing mounted models and free-flight models. These methods complement the usual ballistic range firings and sting-flexure mounted model approaches for obtaining pitch-damping data. Author

N63-13030 RAND Corp., Santa Monica, Calif.
A STUDY OF PASSIVE COMMUNICATION SATELLITES
S. H. Reiger Feb. 1963 222 p 22 refs
(NASA Contract NASr-21)
(R-415-NASA) OTS: $15.00 ph, $6.86 mf

A study of passive communication satellites covers four main problem areas: (1) the technical parameters that determine the capability of a communication link when a satellite is mutually visible from a pair of terminals, (2) the orbital configuration of the satellites and its effect on satellite visibility and continuity of service, (3) significant systems tradeoffs and their influence on systems cost, and (4) comparison with systems using active repeaters. J.R.C.

N63-13104 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE SOUTHERN SKY SURVEY PAYLOAD
Richard M. Windsor Washington, NASA, Feb. 1963 17 p 7 refs
(NASA TN D-1719) OTS: $0.50

Four Skylark rockets were fired from Woomera Missile Range, Australia, to measure stellar fluxes and nebulosities at energy bands between 1050A and 2800A. The payloads contained two basic types of detector systems: photomultipliers for the spectral region between 1900A and 2800A, and ionization chambers for the 1050A to 1500A range. Data acquisition was optimized by a spin control gas jet system. Also described are the vehicle, field operations, and performance. Author

N63-13292 National Aeronautics and Space Administration, Washington, D.C.
OUR ORBITING OBSERVATORIES
James E. Webb Repr. from Grumman Horizons, Spring, 1962 2 p

Orbiting observatories are discussed. The Orbiting Solar Observatory is a stabilized space platform designed for continuous observation of that giant nuclear reactor, our sun, and its atmosphere in the X-ray, ultraviolet, and infrared regions of the spectrum. One of the instruments provided by NASA's Goddard Space Flight Center, for example, is an X-ray spectrometer. Sounding rocket experiments have shown that X-rays are generated by the sun. Knowledge of the intensity and "hardness" of this X-radiation is important in understanding the nature of the physical processes that take place in the sun. That knowledge, in turn, may have its practical applications in helping us to harness the power of hydrogen fusion for the benefit of mankind. A special feature of this observatory is its ability to point continuously at the center of the sun to an accuracy of two minutes of arc, or less. Our first Astronomical Observatory is scheduled for launching in 1965. The primary experiments for the first three Astronomical Observatories will be centered on stellar astronomy in the ultraviolet range. Instruments of later observatories will be trained on the sun and the planets. An active life of a year or more is desired for each observatory. All will be launched into circular orbits 500 miles above the earth. The Geophysical Observatories will be in 1963 and 1964. They will be used to study the earth's atmosphere, ionosphere, geomagnetic field, radiation belt, energy particles, cosmic rays, and the transition region between the ionosphere and true space. I.v.L.

33 STRESSES AND LOADS

Includes: fatigue; vibration; flutter; and structural tests.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

N63-12887 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALYSIS OF THE FLUTTER OF FLAT RECTANGULAR PANELS ON THE BASIS OF EXACT THREE-DIMENSIONAL LINEARIZED SUPERSONIC POTENTIAL FLOW
H. J. Cunningham N. Y., Inst. of the Aerospace Sciences, [1963] 20 p 8 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963
(IAS Paper-63-22) IAS: $0.50 members, $1.00 nonmembers

A procedure has been developed for computing flutter boundaries and characteristics of single finite panels particularly at low supersonic Mach numbers where static and quasi-static aerodynamic approximations are not valid. The procedure uses air forces from the exact linearized potential-flow theory. Since for finite panels closed-form mathematical expressions for the generalized aerodynamic forces have not been determined, a more laborious method has been used on a high-speed computing machine. The panel is considered as finely divided into many boxes, and the aerodynamic influence

coefficient between all pairs of boxes is computed by numerical integration. The flutter analysis is a modal type of analysis, which with the box method can be used for calculation of the flutter stability of any flat or nearly flat panel, whether unstressed or stressed (as by thermal expansion), whether of isotropic or anisotropic stiffness, and even for buckled panels for which the flutter is a small-amplitude, simple harmonic, superimposed motion to which linear theory would apply. Author

N63-12888 Southwest Research Inst., San Antonio, Tex.

BENDING VIBRATIONS OF A CIRCULAR CYLINDRICAL SHELL WITH AN INTERNAL LIQUID HAVING A FREE SURFACE

Ulric S. Lindholm, Wen-Hwa Chu, Daniel D. Kana, and H. Norman Abramson N. Y. Inst. of the Aerospace Sciences [1963] 16 p 6 refs Presented at the IAS 31st Annual Meeting, N. Y., Jan. 21-23, 1963

(NASA Contract NASw-146)

(IAS Paper-63-24) IAS: $0.50 members, $1.00 nonmembers

Resonant bending frequencies and mode shapes were determined experimentally for a thin circular cylindrical shell containing an internal liquid with a free surface. The measured increase in frequency between uncapped and capped partially filled tanks of two different end conditions is generally in agreement with theoretical predictions. Differences between theory and experiment are attributed primarily to variations of actual mode shapes from those assumed in the theory. This is true for both cantilever and pin-ended tanks, with the latter being even more complicated by a strong dependence of mode shape on liquid depth. Significant coupling occurred between bending and breathing shell responses, becoming increasingly important with decreasing tank fineness ratio. Author

N63-12952 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL AND CALCULATED RESULTS OF A FLUTTER INVESTIGATION OF SOME VERY LOW ASPECT-RATIO FLAT-PLATE SURFACES AT MACH NUMBERS FROM 0.62 TO 3.00

Perry W. Hanson and Gilbert M. Levey Washington, NASA, Aug. 1959 24 p 6 refs

(NASA TM-X-53) OTS: $0.75 (Declassified)

Flutter characteristics of semispan models with two types of planforms and panel aspect ratios of 0.728, 0.536, and 0.353 were investigated. Modal-type calculations with the use of first-order piston-theory aerodynamic forces were made for some supersonic cases. Generally, the clipped-tip-delta planforms were more susceptible to flutter than the delta planforms. The theoretical flutter boundaries agreed with the experimental boundaries within 20 percent. Author

N63-13000 Illinois U. Engineering Experiment Station, Urbana

AN INTRODUCTION TO VISCOELASTIC ANALYSIS

Harry H. Hilton Nov. 1962 164 p 145 refs

(AAE-62-1)

A unified, introductory treatment of three-dimensional viscoelasticity theory is presented. Generalized homogeneous, nonhomogeneous, isotropic or anisotropic viscoelastic stress-strain relations are constructed and analyzed in integral and differential forms. Separation of variable and integral transform elastic-viscoelastic analogies are discussed for quasi-static and dynamic linear problems. Illustrative examples, such as those of beams, thick-walled cylinders, wave propagation, vibrating reeds, indentation, and of thermal stresses by use of temperature shift function, are presented. Special nonlinear viscoelastic laws, their associated elastic-viscoelastic analogy, and their application to creep rupture are also introduced. A bibliography of 145 titles is included. Author

N63-13018 Midwest Research Inst. Kansas City, Mo.

SUPERSONIC FLUTTER OF AIRFRAMES WITH FLEXIBLE BODIES Final Report [25 Oct. 1961-24 Nov. 1962]

John E. Yates Dec. 31, 1962 106 p 9 refs

(Contract NOw-62-0099-d)

The symmetric-longitudinal-flutter characteristics of a body of revolution with centrally mounted delta wing are investigated in the low supersonic regime. The influence of the body on the flutter behavior of the composite configuration is of primary concern. Equations of motion are developed, and generalized aerodynamic forces are derived from slender-body and quasi-slender-body theory. Rigid-body stability criteria are given, and two methods for calculating parametric flutter boundaries are discussed.

The results indicate that wing-body flutter in the low supersonic regime is essentially a steady-state aerodynamic phenomenon. The dominant flutter mode consists of a strong coupling between first bending and the rigid-body degrees of freedom. It is found that increasing the body diameter for a fixed-wing geometry is stabilizing. Increasing the forebody stiffness is destabilizing. It is concluded that slender-body theory is in general inadequate to predict wing-body flutter in the low supersonic regime. Author

N63-13050 Stanford U., Calif.

FINITE DEFORMATION OF A PRESTRESSED ELASTIC MEMBRANE

W. Nachbar Nov. 1962 57 p 7 refs

(Grant DA-ARO(D)-31-124-G299)

(SUDAER-141; AROD-3106-2)

The rotationally symmetric deformation of a prestressed annular elastic membrane under a normal line load applied to the inner edge is considered. A second-order nonlinear differential equation is found which determines the solution for small strains and arbitrary rotations. When the restriction to moderate rotation is introduced, this equation reduces to the nonlinear equation found by Schwerin. Under the moderate rotation assumption, existence, uniqueness, and "wrinkle" stability of solutions to a particular boundary value problem, which represents normal loads applied to a rigid, central circular insert, are examined. Unique and stable solutions are shown to exist under sufficiently small normal loads for all permissible values of the Poisson's ratio and of the radius ratio (i.e., radius of disk to radius of outer boundary). The deformations and stresses for very small radius ratios ("concentrated" loads) are examined, and it is shown that there exists an optimum value of prestress for which the membrane can support the maximum normal load. For small radius ratios, moreover, the conditions of small strain and wrinkle stability are shown to imply the validity of the moderate rotations assumption, but this implication does not follow if the radius ratio is close to unity. Author

N63-13062 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

FREE OSCILLATIONS OF A GRAVITATING SOLID SPHERE. PART II: SPHEROIDAL OSCILLATIONS

Russell E. Carr Jan. 15, 1963 28 p 4 refs

(NASA Contract NAS7-100)

(JPL-TR-32-372) OTS: $2.60 ph, $1.04 mf

The problem of determining the free spheroidal oscillations of a gravitating solid sphere, with the assumption of radial symmetry in the structure of the sphere as well as constant density and elastic parameters in a small neighborhood of the origin, is treated. The procedure for satisfying regularity requirements at the origin, as well as surface boundary conditions, is given in detail. The manner of obtaining the spheroidal frequency spectrum as well as representative solutions is given, and some details to be considered in the numerical solution are discussed. Author

N63-13063 Thompson Ramo Wooldridge, Inc. RW Div., Canoga Park, Calif.

ADVANCED CONCEPTS OF STOCHASTIC PROCESSES AND STATISTICS FOR FLIGHT VEHICLE VIBRATION ESTIMATION AND MEASUREMENT [Final Report]

Julius S. Bendat, Loren D. Enochson, G. Harold Klein, and Alan G. Piersol Wright-Patterson AFB, Ohio, Flight Dynamics Lab., Dec. 1962 502 p 47 refs
(Contract AF 33(657)-7459)
(ASD-TDR-62-973)

Results from theoretical and experimental studies on random signal estimation and measurement pertinent to flight vehicle vibration problems are presented. Author

N63-13069 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECT OF SEVERAL OPERATING AND PROCESSING VARIABLES ON ROLLING FATIGUE

W. J. Anderson and E. V. Zaretsky Amsterdam, Elsevier Publ. Co. [1961] Repr. from Proc. of a Symp. on Rolling Contact Phenomena p 317-345 30 refs

Rolling contact fatigue experiments were conducted in two bench-type fatigue testers called the fatigue spin rig and the five-ball fatigue tester. Tests were run at maximum Hertz stresses to 800,000 psi and temperatures to 700° F. The effects on fatigue of load, speed, temperature, lubricant viscosity and base stock, material hardness, and fiber orientation are reported. The inverse cubic relationship between load and life, which holds true for ball bearings, was found to be true for SAE 52100 balls in the spin rig. Higher lubricant viscosity increased fatigue life. The type of lubricant had a significant effect on fatigue; life was forty times greater with a silicone than with an adipate of comparable viscosity. Relative fatigue life with various types of lubricant could be predicted from their pressure-viscosity coefficients. Increasing temperature was detrimental to fatigue life. Speed had little effect on life under conditions where hydrodynamic lubrication was not present. Fatigue life improved with higher material hardness, improvements in load capacity being of the order of 30 to 100 percent over the hardness range tested. Areas with material fibers oriented perpendicularly, or nearly so, to the surface were found to be weaker in fatigue than areas with fibers parallel to the surface. Author

N63-13174 General Electric Co. Space Sciences Lab., Philadelphia, Pa.

ELASTIC CONSTANTS OF LAMINATES OF ORTHOTROPIC PLATES

B. Walter Rosen June 1962 13 p 1 ref
(Contract AF 04(647)-617)
(Space Mechanics Memo. 112)

Laminates of orthotropic plates alternately oriented in each of two directions are analyzed. The elastic constants of the laminate are presented as functions of the angle between plates and the elastic constants of the individual plates. Author

N63-13235 Directorate of Materials and Processes, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

ELEVATED TEMPERATURE FATIGUE TESTING OF TURBINE BUCKETS. PART I. CALCULATIONS OF NATURAL FREQUENCIES AND STRESSES AND PROPOSED TESTING METHODS

Albrecht Herzog *In* Library of Congress. Science and Technology Div., Washington, D. C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 5-14 13 refs (See N63-13234 07-01)

Testing methods have been developed for turbine buckets under simulated service conditions to determine the influences of stress on bucket failure. The turbine wheel is supported in a stationary test stand, and the service conditions are simulated as follows: the centrifugal force by a static axial load to the bucket, vibrations (first and second harmonics) by a magnetic driver, and temperature by an induction heater. Measurements were made of these stresses with a 10-point strain gage, a Strobotac optical system, and a Radiamatic pyrometer. An evaluation of the data obtained by this method shows good agreement with calculated stresses and frequencies. Failure locations and appearances obtained agreed well with those observed in many service failures. It is concluded that these tests can provide information which may be applied to new bucket designs. R.C.M.

N63-13236 Directorate of Materials and Processes, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

ELEVATED TEMPERATURE FATIGUE TESTING OF TURBINE BUCKETS. PART II. FATIGUE TESTS OF TURBINE BUCKETS UNDER STATIC AXIAL AND SUPERIMPOSED VIBRATIONAL BENDING LOADS

Albrecht Herzog *In* Library of Congress. Science and Technology Div., Washington, D. C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 15-38 15 refs (See N63-13234 07-01)

The fatigue investigation of turbine blades in a special device, permitting the application of static axial and superimposed vibrational bending loads by means of an electromagnet, is discussed. The excitation of the vibration of the axially loaded bucket was adjusted to the fundamental frequency of this system. The most important factors causing damping effects end energy losses during vibration are considered. Special attention is given to the measuring methods for obtaining stress and deflection values of the vibrating bucket under dynamic load. The tests were conducted at room and at elevated temperatures. The results are discussed and compared with fatigue tests under similar conditions using simple specimens and standard testing devices. Author

N63-13237 Arcweld Mfg. Co., Grove City, Pa.

ELEVATED-TEMPERATURE TESTING PROCEDURES. CONTINUOUS RECORDINGS OF TIME-DEFORMATION READINGS DURING CREEP-RUPTURE TESTING AT TEMPERATURES UP TO 1200° F

William H. Rector *In* Library of Congress. Science and Technology Div., Washington, D. C. Charles J. Cleary Awards for Papers on Material Sciences 1962 p 39-48 (See N63-13234 07-01)

A new method of recording deformation during creep-rupture testing at temperatures up to 1200° F is presented. This method has the advantages of: (1) obtaining a continuous time-deformation record up to failure, compared to the intermittent readings obtained using the former manual method and (2) being completely automatic and saving the technician's time required to make manual measurements. This method employs cameras to record the data. A description of the equipment is given. Author

N63-13261 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASURED AND CALCULATED SUBSONIC AND TRANSONIC FLUTTER CHARACTERISTICS OF A 45° SWEPTBACK PLANFORM IN AIR AND IN FREON-12 IN THE LANGLEY TRANSONIC DYNAMICS TUNNEL

E. Carson Yates, Jr., Norman S. Land, and Jerome T. Foughner, Jr. Washington, NASA, Mar. 1963 44 p 12 refs
(NASA TN D-1616) OTS: $1.25

In order to investigate the reliability of flutter data measured in the Langley transonic dynamics tunnel, an experimental and theoretical subsonic and transonic flutter study has been conducted in air and in Freon-12 in this facility. The wing planform employed had an aspect ratio of 4.0, a taper ratio of 0.6, and 45° of quarter-chord sweepback. A sting-mounted full-span model was tested in addition to three sizes of wall-mounted semispan models. A wide range of mass ratio was covered by the tests in air and by flutter calculations made by the modified strip-analysis method of NACA Research Memorandum L57L10. A limited amount of data was obtained in Freon-12. Results of the tests in air and in Freon-12 are in good agreement with

the flutter calculations at all Mach numbers. The test data compare favorably with previously published transonic flutter data for the same wing planform. The results indicate that flutter characteristics obtained in Freon-12 may be interpreted directly as equivalent flutter data in air at the same mass ratio and Mach number. Author

N63-13291 Brown U. Div. of Applied Mathematics, Providence, R.I.

ON THE ANALYSIS OF THERMAL STRESSES IN VISCOELASTIC SOLIDS Technical Report No. 19

Eli Sternberg Feb. 1963 66 p 60 refs To be presented at the International Conf. on High Temperature Structures, Columbia U., New York, 1963

(Contract Nonr-562(25))

A quasi-static analysis of thermal stresses in homogeneous and isotropic linear viscoelastic solids is presented. The following are considered: (1) thermoviscoelasticity theory within the assumption that the mechanical response of the material is temperature-independent; and (2) temperature-dependent viscoelastic solids with particular emphasis on the theory of thermorheologically simple materials. D.B.

N63-13293 Royal Inst. of Tech. Inst. for Materials Testing, Stockholm (Sweden)

A SPECIAL CASE OF UNI-AXIAL CREEP, INCLUDING RUPTURE

R. A. de Bont 1962 24 p 7 refs

(*Its* Publication No. 137)

A survey is given of the consequences of Odqvist's creep law and Kachanov's creep rupture hypothesis with respect to: a given range of constant uni-axial deformation speeds, selected material constants, and certain restricting conditions. Author

N63-13298 Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge

PLASTIC DEFORMATION OF THIN BRAZED JOINTS IN SHEAR

C. W. Shaw, L. A. Shepard, and J. Wulff Nov. 1962 53 p 22 refs

(Contract AF 49(638)-775)

(ASRL-TR-94-3)

The plastic behavior of the more ductile phase of a two phase material was simulated in shear tests on thin silver joints brazed in tubular steel specimens. Both the yield strength and the work hardening rate of the silver were increased by the presence of the rigid interfaces. At 10 percent strain, the flow stress of the thin joints was 1½ as great as fine grained polycrystalline silver. Deformations of the silver near the steel interfaces was severely limited even at large strains, resulting in a gross strain inhomogeneity across the joint. These effects were postulated to arise from the constraint of slip by the non-yielding interfaces. Author

34 STRUCTURAL DESIGN

Includes: structural elements; and weight analysis.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

N63-13256 Tokyo U. Inst. of Industrial Science (Japan)

THE CONSTRUCTION OF THE KAPPA ROCKETS, WITH SPECIAL CONSIDERATION OF THE K-8

Daikichiro Mori *In* NASA, Washington, D.C. Development of Sounding Rockets in Japan Mar. 1963 p 110-121 (See N63-13251 07-04) OTS: $3.00

The problems encountered in the construction of Kappa rockets are outlined, and their solutions are discussed. The items covered include the rocket chamber, the tail, the airframe, and the launcher. Vibration of the airframe and aerodynamic heating problems are considered. R.C.M.

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